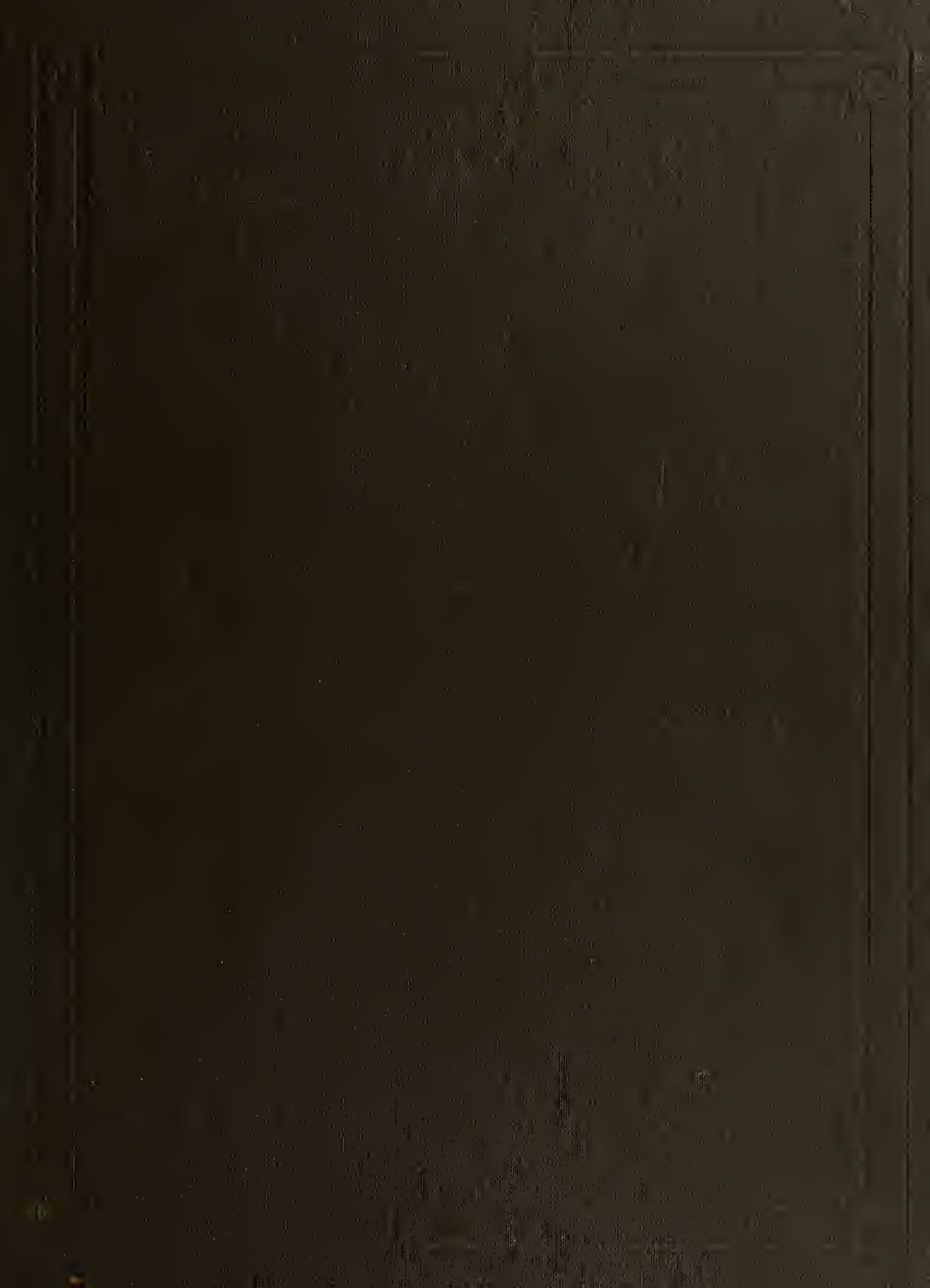
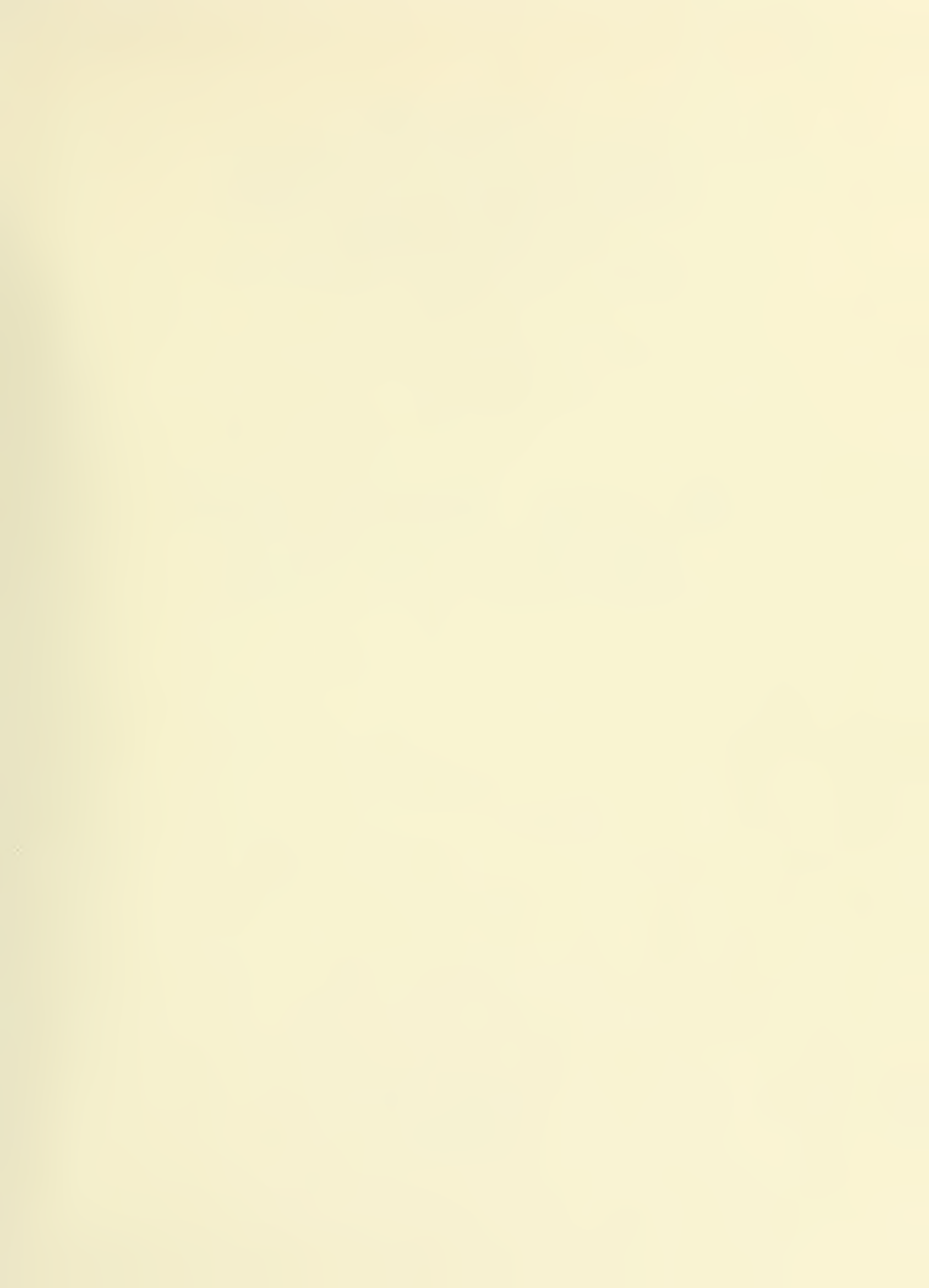








REPORT OF THE
JOINT EXPEDITION OF THE BRITISH SCHOOL OF
ARCHAEOLOGY IN JERUSALEM AND THE
AMERICAN SCHOOL OF PREHISTORIC RESEARCH
IN ASSOCIATION WITH THE
ROYAL COLLEGE OF SURGEONS OF ENGLAND
1929–1937

THE STONE AGE OF MOUNT CARMEL

AMS PRESS
NEW YORK

Library of Congress Cataloging in Publication Data

[Joint Expedition of the British School of Archaeology in Jerusalem and the American School of Prehistoric Research, 1929–1934]
The stone age of Mount Carmel.

Reprint of the 1937–1939 ed. published by Clarendon Press, Oxford.
Includes bibliographies and indexes.
CONTENTS: v. 1. Garrod, D. A. E. and Bate, D. M. A. Excavations at the Wady el-Mughara.—v. 2. McCown, T. D. and Keith, A. The fossil human remains from the Levalloiso-Mousterian.
1. Paleolithic period—Palestine. 2. Carmel, Mount, Palestine—Antiquities. 3. Palestine—Antiquities. 4. Fossil man—Palestine. I. Garrod, Dorothy Annie Elizabeth, 1892– II. Title.
GN772.32.P34J64 1980 933 77-86432

International Standard Book Number—
Complete Set: 0-404-16650-4
Volume II: 0-404-16652-0

Reprinted from the edition of 1937–1939, Oxford, from an original in the collections of the Ohio State University Libraries. Trim size and text area have been maintained.

MANUFACTURED
IN THE UNITED STATES OF AMERICA

FOREWORD

By PROFESSOR JOHN BEATTIE

Conservator of the Museum, Royal College of Surgeons of England

FOR the past eighty years, students of human evolution have endeavoured to piece together the information derived from a close study of the fragmentary remains of fossil man. The pieces of the mosaic have fitted together in such a way that reasonably clear pictures of the ancient types of man have emerged. Were our knowledge more complete, there would be less disagreement about their relative positions in the greater picture of human evolution. It has yet to be determined whether any of the types which appeared and then disappeared in early Pleistocene times were ancestral to modern man or were but the final products of separate lines of development from a common ancestral type. These problems are the greatest puzzles which confront the physical anthropologist to-day.

The Mount Carmel discovery will be regarded in the future not so much as a great accession to the numbers of Palaeolithic man available for study, but as the first evidence that a number of Pleistocene individuals living in a small area and separated from each other by inconsiderable intervals of time, did vary tremendously in their physical characters. Whether the evidence will be regarded as pointing to the development of modern man from a Palaeoanthropic ancestor, or as a good example of Palaeoanthropic miscegenation, the future alone can determine. The authors have presented their case for an inherent variability of the Mount Carmel community and for the possibility of modern man being developed from one of the genetic strains represented in the Mount Carmel peoples.

In these times of nationalism it is good to see the realization of a piece of work which has been brought to fruition by international goodwill and mutual understanding. It has been financed by three institutions separated by a wide ocean and the Middle Sea, and under two different flags. Men and women interested in human palaeontology in the two great English-speaking countries have been brought together and their energies directed to the working-out of the most fascinating of all the discoveries of fossil man. The American School of Prehistoric Research, the British School of Archaeology in Jerusalem, and the Royal College of Surgeons of England have each contributed to the common end.

Early in 1933 great blocks of stone, encased in plaster and wood at Mount Carmel by Mr. T. D. McCown, were deposited with difficulty and with the expenditure of much human energy in the basement of the Royal College of Surgeons in London. Journey's end was reached only after immense transport difficulties in Palestine, which would have daunted even an enthusiast. Later that year work was begun by Mr. McCown and his able assistants on the extrication of the skeletons. The story of this is found in later pages. Two and a half years of painstaking work, first at the Royal College of Surgeons in London and later at the Buckston Browne Research Farm of the Royal College of Surgeons, were necessary to complete the extrication, cleaning, and repair of the

skeletal remains. Another year and a half was required to study, measure, record, and photograph every single bone and bone fragment and then to prepare the text of this volume. During this time Sir Arthur Keith and Mr. McCown worked together at the Buckston Browne Farm where a laboratory was set up and equipped for the work.

The arrangement of the descriptions of the skeletal parts of the Mount Carmel people was determined by the order in which the various bones became available for examination. Quite by accident it had the fortunate advantage of giving a new approach to the analysis of the structural characters of the fossil bones and of emphasizing the less known and less considered parts. The systematic osteology, therefore, commences with the bones of the foot, then passes, in ascending order, to the bones of the lower limb, trunk, and upper limb, and ends with an account of the skulls and the endocranial casts.

The authors have had the peculiar advantage of dealing with the most complete and accurately dated discovery of mid-Pleistocene man hitherto brought to light. They have introduced new methods of comparison which it is hoped may be of service to future workers in this field. By a full use of drawings and photographs and by avoiding highly technical terms, as far as is possible in a scientific treatise, they have attempted to make their descriptions of value to non-technical readers.

The three years 1934–7 are remembered by me as a gradual change in the noises I came to associate with the work: first electro-pneumatic drills, small in size but, in brick-lined cellars, the equals of any road-drill, then the delicate chipping of hammer and chisel, gradually replaced by the whirr and screech of dental drills as individual bones were cleaned of the matrix, and finally the scratch of pen on paper and the clicking of photographic shutters. I have seen, too, a perfect co-ordination of effort: the technical skill, patience, and the pioneer spirit of McCown harnessed to the experience, the knowledge, and the understanding of Keith. What one lacked the other seemed to have, and this book is the result of two hands and two minds successfully co-ordinated in a joint enterprise.

PREFACE

THE present Memoir was originally planned to complement Volume I of *The Stone Age of Mount Carmel* in that it would describe the human remains from all the prehistoric burials contained in the strata filling the three Wady Mughara caves. We have thought it wiser, however, to restrict the account here to a statement of the facts, with our conclusions, regarding the Levalloiso-Mousterian inhabitants of et-Tabūn, of the Mugharet es-Skhūl and the Mugharet el Wad. Various considerations, including the size of the volume, but particularly the essentially different racial character of the Natufian people of the Wady Mughara caves, have compelled us to adopt this course. The Natufian material is in course of preparation and will be published in the *American Journal of Physical Anthropology*. For a careful, full, and detailed description of the excavation of the caves and of the analysis of their cultural and faunal data readers are referred to Volume I of *The Stone Age of Mount Carmel*.

Present and future students of the evolution of man and of his changing physical characters who wish to refer to the original specimens—the skulls, teeth, and bones—will find the Skhūl skeletons, Skhūl I and Skhūl IV, the mandible Tabūn II, as well as the incomplete femur shaft from the Acheulean of et-Tabūn housed in the Museum of the Department of Antiquities in Jerusalem.

To the Royal College of Surgeons, England, have been allotted:

(1) The skeleton of the woman from et-Tabūn (Tabūn I).

(2) The imperfect skeleton of a man from es-Skhūl (Skhūl IX).

(3) The isolated bones from et-Tabūn excepting the fragment of femur (Tabūn E*a*).

(4) The isolated teeth from et-Tabūn (Series II, IV) (see p. 10).

These specimens have joined that precious and remarkable human document, the adult female skull from Gibraltar in the Collection of the Museum of the Royal College of Surgeons of England.

The American School of Prehistoric Research has entrusted to the safe keeping of the Peabody Museum of Harvard University the skull and skeleton of Skhūl V. To this are added Skhūl II (a woman, fragmentary)
Skhūl III (a man, very fragmentary)
Skhūl VI (a man, skull crushed)
Skhūl VII (a woman, imperfect)
Skhūl VIII (a child, fragmentary).

To these are added the isolated teeth from es-Skhūl and those from et-Tabūn included in Series I, III, V (see p. 10).

Acknowledgement of our thanks and gratitude to the Institutions and the many individuals who have supported and helped to make possible the discovery and description of the remarkable human fossils is a welcome task, but no light one. All of those who are interested in the early history of man and in his bodily evolution owe a great debt to the Trustees, the President, Mr. A. L. Green, and especially to the Director, Dr. George Grant MacCurdy of the American School of Prehistoric Research. Equally, all of us are indebted to the Council of the British School of Archaeology in Jerusalem and its then

Director, Mr. J. W. Crowfoot, and to the Council of the Royal College of Surgeons of England, the Groves Trustees of that Institution and to its Conservator of the Museum and Director of Research, Professor John Beattie. The American School and the British School of Archaeology co-operated jointly to support Miss Garrod's six seasons of excavations (1929–33) in the Wady Mughara. The Royal College of Surgeons became the active partner with the American School of Prehistoric Research in 1933 and has provided joint financial support, as well as placing unreservedly at our disposal the exceptional facilities of its Museum in Lincoln's Inn Fields and of the Buckston Browne Research Farm in carrying on four years of preparation and study of the fossil bones. The Director, Mr. E. T. Richmond, and the Department of Antiquities, Government of Palestine, receive our thanks for their consideration both at the time of the removal of the skeletons and, latterly, for their patience with the delay in restoring their specimens to them.

Our colleagues, Miss Dorothy Garrod and Miss Dorothea Bate, deserve, and are wholeheartedly given, our warmest gratitude for their never-failing help and advice. Miss Garrod, as Director of the Joint Expedition, cannot receive too much credit for the exceptional manner in which she led the Expedition and laboured so successfully in the presentation of its results. Miss Bate's definitive and brilliant studies upon the great collection of animal remains from the caves has given us a sure foundation from which to estimate the chronological position of the fossil human remains. Miss Garrod has acknowledged in the preface to Volume I our indebtedness to the many individuals who have shared in the actual labour of excavation or who have assisted that work in other ways. The four years of work in London upon the fossil human bones from the caves has provided an equal or greater number of people to whom we are grateful for a variety of assistance, advice, and encouragement. Miss Margot Collett devoted three years to the difficult and tedious task of excavating the bones from the matrix blocks in which they were embedded and to cleaning and helping in the reconstruction of these precious specimens. Mr. W. C. Willmott was engaged in the same labours, not, we hope, thankless ones. Miss Kathleen Parbury most generously placed her artistic abilities at our disposal, drawing to scale the plans of the burial positions of the more complete Skhūl skeletons, used both here and in Volume I; modelled and made half-size casts of Skhūl IV and V, directed and carried through with success the casting, life-size, of the complete burial of Skhūl IV, and from the field plans and sections modelled to scale and made casts of the cave and necropolis of the Mugharet es-Skhūl. To the staff of the Museum and the Research Laboratories are due our thanks for their numerous and more than incidental services. Mr. Ernest Smith, Mr. F. Watson, Mr. S. P. Steward, and Mr. W. E. Thompson are to be specially mentioned in this connexion.

To the many individuals who have, in one way or another, personally encouraged and assisted our labours we offer our sincere thanks and appreciation. Many thanks to Professor John L. Myres, Mr. Kennedy Cassels, Mr. Donald Scott, Professor E. A. Hooton, Mr. R. H. Burne, Miss Miriam Tildesley, Dr. G. M. Morant, Professor J. P. Hill, Professor H. A. Harris, Professor Woollard, Dr. David Slome, Mr. James Heslop, Mr. F. S. Gowar, Mr. William Le-Fanu.

Mr. F. O. Barlow, to whom has been entrusted the reproduction of the more complete skulls and bones,[1] we thank for the excellent endocranial casts of Skhūl I and Skhūl V.

[1] The reproduction of the fossil material from Mount Carmel has been entrusted solely to R. F. Damon & Company, 45 Hazlewell Road, London, S.W., and can be obtained from them.

Mr. McCown wishes to express his personal thanks and deep appreciation to the Trustees and the Director of the American School of Prehistoric Research for Fellowships in 1932 and again in 1935–7, and to the Regents of the University of California for the Taussig (1933–4) and the Amy Bowles Johnson Memorial Fellowships (1934–5), which have made possible his continued and uninterrupted participation in this research. To the Delegates and the staff of the Clarendon Press we give our sincere thanks for the financial support, the care and labour devoted to publishing this study. We are also especially grateful to Sir Robert Mond, to the Royal Society, and to the American Council of Learned Societies for financial support in connexion with the publication of both volumes.

The length of time required to prepare and to study fully the human remains from Mount Carmel exceeded all our anticipations, but we may say without exaggeration that both the material itself and the circumstances in which it was found are without a parallel for similar stages in the story of Man's evolution. As the size of the task exceeded our original expectations, so, too, the importance of the specimens appears to us to have correspondingly increased.



CONTENTS



LIST OF TABLES



LIST OF ILLUSTRATIONS

FIGURES

Between pages 40 and 41.

Between pages 54 and 55.

Between pages 70 and 71.

Between pages 92 and 93.

Between pages 114 and 115.

Between pages 322 and 323.

Between pages 344 and 345.

Between pages 358 and 359.

PLATES (*At end*)

CHAPTER I

THE FOSSIL REMAINS

AN ENUMERATION OF THE INDIVIDUALS WITH A RÉSUMÉ OF THE EVIDENCE BEARING ON THEIR ANTIQUITY

THE fossil human skulls and skeletons which form the subject of this study were found in caves on the western slope of Mount Carmel in Palestine. We do not propose to give here an account of the circumstances concerning their discovery. The facts relating to and the conclusions derived from the archaeological excavations have been fully set forth in Volume I of *The Stone Age of Mount Carmel*. In that monograph the reader will find a detailed description of the artifacts and of the fossil fauna of the strata in which were found the human remains and an account of the situation and position of the human burials discovered in the Mugharet es-Skhūl and et-Tabūn. Plans, sections, and photographs of the caves and of the burials make clear the nature of these ancient cemeteries (see Frontispiece and Pl. I).

The assemblage of fossil human material which it has been our good fortune to study is both exceptionally complete and well preserved. There are individuals of both sexes, children as well as adults. We began our study of these remarkable specimens by turning our attention first to the limb-bones, the bony elements of the back and of the trunk, reserving to the last a consideration of the skulls, teeth, and jaws. One circumstance which determined this unusual procedure was that the parts first named were those that were first ready for anatomical investigation. There were also a number of other reasons which persuaded us to adopt this course. It appeared important to us to record fully a very great amount of new knowledge regarding many little-known parts of the skeletons of men of the middle Palaeolithic. Primarily, however, we were influenced by a desire to obtain as clear a view as possible of the bodily characters of these ancient people and their racial relationships, independent of their crania. The crania of the Neanderthal people of Europe have been much studied, and on both archaeological and geopalaeontological grounds comparison of the Mount Carmel fossil skulls with those of the Mousterian inhabitants of Europe was clearly indicated. We have in great measure used our study of the Carmel crania as confirmation or contradiction of our deductions from the skeletons. A glance at the Table of Contents will make clear to the reader that we have begun with the feet, progressed upwards to the hips, then up the spine, following which is the description of the thorax, the hands and arms, and finally the teeth, jaws, skulls, and endo-cranial casts. Our conclusions and a summary of the significant physical features which constitute the racial links with other fossil and living peoples come at the end.

The material available to us for study is enumerated below and in addition to this the reader will find a list at the beginning of each chapter of the specimens therein described. With the exception of certain specimens from the Mugharet el-Wad and et-Tabūn which are specially noted below, the human remains come from the Levalloiso-Mousterian layers of et-Tabūn (Layers C, B) and of the Mugharet es-Skhūl (Layer B).

FROM THE MUGHARET ES-SKHŪL

Skhūl I. Contracted burial of an infant, about four to four and a half years of age. Sex probably male. Bone moderately mineralized, with surface parchment brown in colour.

Skull: Frontal; parietals; most of the occipital and the left temporal bone remains. The base is defective and the right temporal is represented by the petrous portion only. Face lacking, but there remain from the upper jaw ten teeth—five crowns of the permanent dentition and five milk-teeth.

Mandible: Incomplete. Right ascending ramus absent, as is the posterior part of the left ramus. The lower border of the symphysis is defective and the body of the mandible carrying the left canine and milk molar is missing.

Vertebrae: The axis is represented by two fragments, one of the body and the other representing the articular process of the right side. The atlas is represented by two fragments of the posterior arch with small portions of each lateral mass. The bodies and transverse processes of cervicals 3–7 remain. The first dorsal vertebra is very nearly intact. The greater part of the twelfth dorsal is also present, and there are portions of the second, third, and fourth lumbar vertebrae.

Ribs: On the left side the first and second are lacking, but there is some part of all the others from both sides.

Scapulae: The right scapula is represented by the lower two-thirds of the axillary border with the inferior angle as well as a small part of the plate or corpus. There is also a small fragment of the glenoid. Left scapulae lacking.

Claviculae: Left bone complete. Right bone represented by part of the shaft and a fragment of the acromial end.

Sternum: Distal two-thirds of manubrium. Intact first segment and fragment of the second segment of the corpus.

Humeri: Left complete except for proximal end. The right bone consists of the proximal end and the shaft; the distal extremity is missing.

Radii: Left bone complete. Right bone is lacking.

Ulnae: Neither is preserved.

Hand: Neither carpus is preserved. The metacarpals are represented by portions of Left II and III and the intact first right bone. There are six fragments representing metacarpals and proximal phalanges.

Pelvis and Sacrum: About half of the right ilium is present with part of the acetabular cavity, but there is only a small fragment of the middle and posterior part of the left bone. The ischia and pubic parts on both sides are lacking. The sacrum is represented by the body and the left lateral part of the first segment and by a fragment of the body and the spinous process of the second.

Femora: The left bone consists of the whole of the shaft, part of the head, and neck, but the distal end is defective, falling just short of the epiphyseal line. The left bone is represented by four-fifths of the shaft from just distal to the trochanter minor to the popliteal area. A fragment of the inferior part of the left head and neck is also preserved.

Tibiae: The left is complete although the epiphyseal ends are slightly defective. The right bone lacks the proximal end above the tuberosity.

Fibulae: The left fibula is complete. The right bone consists of the entire shaft but the extremities are missing.

Foot: The tarsus consists of the damaged right talus and the intact first cuneiform. The shafts of metatarsals 1–5 are present and the proximal and terminal phalanges of the first digit as well as the proximal and middle phalanges of the second are preserved. The left foot is represented by a fragment of the first metatarsal and its defective proximal phalanx.

SKHŪL II. Adult, age 30–40 years; female.

Skull: There are four chief fragments, the most important being about two-thirds of the supra-orbital torus, including the greater part of the upper border of the right orbit, as well as the whole of the root of the nose. The right temporal bone is represented by the roof of the auditory meatus, the post-glenoid spine, and part of the glenoid cavity. The tympanic plate is lacking. There is a large fragment of the right parietal preserving the sagittal and lambdoid suture. With this is the tabular part of the occipital bone. The left parietal is represented by a large fragment extending from the squamous suture upwards to within a few millimetres of the sagittal suture. The hinder part of the fragment preserves the parietal eminence but the anterior margin falls short of the coronal suture. There are two dozen fragments of this skull, all small and pertaining mostly to the parietals and occipital. There is no part of the face, but some of the upper teeth are present.

Mandible: The fragment includes the symphysis and contains the alveoli from the right M–1 to the left Pm–2.

Humeri: The right humerus is represented by the shaft below the deltoid tuberosity with the upper part of the distal end; the left bone is represented by the distal third of the shaft and by a fragment of the head and neck.

Radii: The tuberosity, neck, and a defective head of the left radius are present. There is no trace of the right bone.

Ulnae: The proximal ends of both bones. The entire olecranon of the right bone is lacking, but about half of this process is preserved on the left bone.

There are no other fragments assignable to this skeleton.

SKHŪL III. Adult, male. This individual is represented by parts of the left leg. The femur is represented by the middle and distal part of the shaft and another fragment representing the trochanter minor. The tibia is represented by the middle half of the shaft. The fibula consists of the defective distal end and about half of the shaft.

SKHŪL IV. Adult, 40–50 years; male.

Skull: This skull, although crushed and distorted, is almost complete, the chief defects being in the base. The palate and the lower left half of the face are nearly intact.

Mandible: The left half is relatively complete. The right half has been crushed and distorted.

Vertebrae: There are fragments of the spines and transverse processes of the dorsal vertebrae, but the only two relatively complete specimens are the eleventh and twelfth. The lumbar vertebrae consist of fragments of the first and the tip of the spine, half the body of the second with part of the spine, and the body of the third, fourth, and fifth with the spines and transverse processes of the latter two.

Ribs: The right side is represented by parts of the ribs from the second to the tenth. Of these the sixth right is very nearly complete, the distal end being defective. On the left side the first rib is represented by the greater part of the shaft, but the proximal end is missing. The remainder of the left series is represented from the sixth to the twelfth rib. The eighth left is intact.

Scapulae: The left scapula is nearly intact, the chief defects being in the region of the glenoid; the coracoid and the tip of the acromion are missing. The right bone is lacking.

Claviculae: Sternal end and part of the shaft of the left bone. The right bone consists of two fragments: a defective sternal end and the middle part of the shaft.

Sternum: Manubrium is absent but the body and the xiphoid are preserved.

Humeri: The left bone is complete. The right bone consists of the entire shaft—somewhat crushed—and the defective distal end. The head and neck are lacking.

Radii: Both bones are nearly complete, but the distal end of the right is somewhat defective and the shaft of the left bone has been crushed.

Ulnae: The left bone is complete and the right bone is also complete, but the olecranon is defective.

Hand: The right carpus is represented by fragments of the os capitatum, os hamatum, os trapezium, os trapezoid, os lunatum, and by the intact os triquetrum and pisiform. The first metacarpal is nearly complete, and the greater portions of the second, third, and fourth are preserved. The fifth consists of the proximal end and part of the shaft. The proximal phalanges 1, 2 (base only), 3, 4, and 5. The middle phalanges 2, 3, 4, and 5. The terminal phalanx 3. The left carpus consists of the head and dorsal half of the os capitatum, the dorsal third of the os hamatum, the os naviculare, os lunatum, os triquetrum, os trapezoid, and the greater part of the os trapezium. The pisiform is represented by two fragments. The metacarpals, one to five, are present, none intact. The proximal phalanges 1, 2 (base only), 3, 4, and 5, middle phalanges 2, 3, 4 (two fragments), and the terminal phalanx of the first. For a representation of the parts preserved see Figs. 100, 101.

Pelvis: Both os coxae are preserved. The sacrum is incomplete, being represented by the proximal part of the body of the first sacral vertebra and by a lower part of the dorsal surface, including the lower end of the sacral canal.

Femora: Both complete, but the lateral condyle of the left bone is somewhat defective.

Tibiae: Both complete, the proximal end of the left bone being slightly crushed. The fibulae are nearly complete but the proximal ends of both are defective.

Foot: The left tarsus is complete as are the metatarsals of this foot; proximal phalanges 1, 2, 3, 4, and 5 (fragments); middle phalanges 2, 3, and 4; terminal phalanges 1 and 2 (defective), 3. The right tarsus is complete except for the cuneiform 3, the cuboid being defective on its proximal and lateral aspect. The base and shaft of the first metatarsal are preserved, but the head is defective. The metacarpals 2, 3, and 4 are

intact, but the fifth consists only of the shaft and part of the distal end; proximal phalanges 1, 2, 3 (base only), middle phalanges 2 and 3 (incomplete); terminal phalanx 1.

SKHŪL V. Adult, about 30–40 years; male.

Skull: Nearly complete, the chief defects being in the region of the nose and middle part of the face.

Mandible: Complete.

Vertebrae: Cervicals 1–7 are relatively intact. All of the dorsal vertebrae are represented, but consist mainly of the spines and laminar arches as far as the tenth; the eleventh and twelfth have parts of the transverse processes and of the vertebral body (Fig. 71). All of the lumbar vertebrae are represented, but mainly by the laminar arches and transverse processes.

Ribs: The left series is the best preserved, extending from the third to the ninth. These have been left articulated with the portions of the dorsal part of the spinal column. No part of either first rib is preserved, but the second and third ribs are represented.

Scapulae: The left scapula is nearly complete. The glenoid has been crushed and the acromial part of the spine is lacking. The right bone consists of about half the axillary border, a defective spine, the superior angle, as well as a fragment comprising the greater part of the coracoid process.

Claviculae: The right bone is nearly intact, but the sternal articular surface is defective. The left bone is represented by the entire shaft, the extremities being absent. The sternum is lacking.

Humeri: Both bones complete, the head of the right one being crushed and the distal end of the left bone being somewhat defective.

Radii: The right bone, the more complete, has a defective head; the distal end is absent. The left bone consists of the shaft from below the tuberosity to some millimetres above the distal articulation.

Ulnae: The right bone is the best preserved, but the olecranon and the distal articulation are somewhat defective. The left bone has nearly the whole of its shaft below the coronoid process but not the distal articulation.

Hand: Parts of both hands are represented, the right carpus being the best preserved and consisting of the greater part of the os capitatum, os hamatum, os triquetrum, os trapezium, and the volar end of the os trapezoid. The right first metacarpal is intact, the greater part of the second (base lacking) is preserved and fragments of the shaft and distal end of the third. The left hand is represented by the os trapezium and os triquetrum (both defective), and by the shaft and base of the third metacarpal and part of the shaft of a proximal phalanx, probably the second or third, and five fragments of middle phalanges.

Pelvis: The right os coxae is represented by the greater part of the ilium, including the auricular facet and by about half of the ischium. The pubic part is absent. The sacrum is represented by a large fragment of the first sacral vertebra, including the articular process for the fifth lumbar of the spine. The left os coxae is lacking.

Femora: The right bone consists of the head, neck, and upper two-thirds of the shaft. The left bone is articulated with the pelvis. This consists of the shaft below the trochanter minor and includes the damaged distal end, the medial condyle being best preserved.

Tibiae: The left tibia is the best preserved and comprises the whole of the shaft with a small part of the proximal articular surface, but the distal articulation is lacking. The right bone consists of the distal third of the shaft but lacks the distal articulation.

Fibulae: Distal two-thirds of the shaft of the left bone.

Foot: The left talus; two fragments of the left calcaneus and the left first metatarsal (defective).

SKHŪL VI. Adult, 30–35 years; male.

Skull: Crushed, incomplete, but preserves the left mastoid, the meatus, and the root of the zygoma, including the adjacent parts of the parietal, the greater part of the occipital (somewhat crushed); the right mastoid.

Mandible: Part of the left ascending ramus with the attached corpus bearing M–3 and containing the root of M–2.

Clavicle: Sternal end and half of the shaft of the left bone.

Humeri: Fragment of the trochlear part of the left bone; fragment of the shaft of the left bone 44 mm. long.

Radii: Proximal part of the shaft of the left bone below the tuberosity.

Ulnae: Proximal part of the shaft of the left bone, the upper part of the olecranon being absent.

Pelvis: Several fragments whose position is uncertain, but including part of the posterior superior spine, a fragment of the ischial tuberosity, and a portion containing part of the anterior superior spine of the ilium.

Femora: Left femur nearly intact, the medial condyle being somewhat defective. The right femur is represented by the greater part of the shaft below the trochanter minor.

Tibiae: Two-thirds of the shaft of the left bone with the distal articulation. The right tibia is badly crushed and shattered and among the fragments appears to be the proximal end of the right fibula.

Foot: The articulated talus, calcaneus, navicular, and cuboid of the left foot remain, but none of the bones are intact. Other bones are too fragmentary for identification.

SKHŪL VII. Adult, 35–40 years; female.

Skull: Badly crushed, the best-preserved parts being the lateral part of the right orbit and right portion of the frontal bone with the greater part of the right malar. The left side consists of part of the left frontal, nearly the whole of the left temporal, including the glenoid fossa, the root of the zygoma, and the mastoid. There are about a score of cranial fragments, the two largest pieces being parts of the parietal and occipital bones.

Mandible: Crushed and incomplete, the chief defects being in the region of the symphysis and of the hinder parts of both ascending rami. Both condyles are preserved, and also the coronoid process on the right side.

Vertebrae: A doubtful fragment of the body of a dorsal vertebra. Bodies are preserved of the fourth and fifth lumbar vertebrae and there is the spinous process which probably belongs to one of these.

Ribs: There are six small fragments, mainly of the left series.

Scapulae: Small fragment of the plate of the left scapula near the inferior angle.

Claviculae: A small fragment of the shaft towards the sternal end of the left bone.

Sternum: Upper half of the corpus comprising the entire first segment and the proximal third of the second.

Humeri: Distal half of the shaft of the right humerus. The left humerus is represented by the distal half of the shaft and a small fragment of the proximal half of the same bone.

Radii: The right bone consists of three fragments: proximal end, middle part of the shaft, and distal end. The left radius comprises the proximal end and nearly the whole of the shaft, but lacks the distal end.

Ulnae: Left complete, with small defects in the olecranon. The right represents the proximal half of the shaft with the olecranon forming a separate fragment attached to part of the trochlea of the right humerus.

Pelvis and Sacrum: The right os coxae is represented by two fragments: the upper border of the ilium bearing the tuberosity and a fragment of the right acetabulum. The left ilium consists of a fragment of the iliac crest and the anterior superior spine. The sacrum is composed of two fragments of the body of the first sacral vertebra with a portion of the second.

Femora: There are parts representing the whole of the right femur, the chief one being the proximal part of the shaft with the trochanters, the other being the distal half of the shaft, with both condyles badly crushed. There is a fragment of the head and neck attached to the right fragment of the acetabular cavity.

Tibiae: The left tibia consists of the proximal half of the shaft, much crushed. There are two fragments of the proximal articular end of the right tibia.

Fibulae: There are small fragments of the shaft, probably of the left bone, and a larger fragment, much crushed, belonging to the right bone.

Foot: The right talus is incomplete and with it is a fragment of the right calcaneus. There is a piece of the fifth metatarsal and about half of the lateral and distal part of the left first cuneiform.

Skhūl VIII. Child, 8–10 years; probably male. Shaft of the right femur; shaft with distal epiphysis of the right tibia, with the right talus and the medial half of the right calcaneus; the right navicular (incomplete). The left tibia is represented by the shaft and the distal epiphysis and with this is articulated the tarsus and metatarsals. The proximal phalanx of the first metatarsal and the proximal of the second are also present. None of these bones is complete. The left fibula is represented by four segments of the shaft as well as the proximal end and the distal end with its epiphysis.

Skhūl IX. Adult, about 50 years; male.

Skull: Consists of the greater part of the calvaria, including the squamous portion of the left temporal. The frontal bone is best preserved on the right side, including the whole of the upper part of the orbit, and with this goes the middle part of the face.

Part of the lateral wall of the left nasal aperture with adjacent portion of the malar is also present.

Vertebrae: Fragments of the fifth lumbar vertebra.

Ribs: Fragments of five ribs of the left side are preserved from the sixth to the eleventh.

Scapulae: The middle and the acromial end of the spine of the left bone is preserved and another fragment represents the crushed axillary border.

Hand: The hand is represented by the shaft of the right fifth metacarpal.

Pelvis and Sacrum: The complete ischiatic and pubic parts of the left os coxae with the acetabulum and adjacent portion of the ilium are preserved. The right pubic and ischiatic parts of the right os coxae surrounding the obturator foramen are also present. In addition, there are fragments from the region of the left auricular region and the posterior superior spine. There is also the greater part of the body of the first sacral vertebra as well as a lateral part of the left side.

Femur: The head, neck, and upper part of the shaft of the left bone remains and is left attached to the left os coxae.

Foot: The greater part of the right first cuneiform is preserved with half of the base of the right first metatarsal. Part of the shaft and of the distal end of the left first metatarsal is also present. The base of the right second metatarsal remains and there are two incomplete middle phalanges of the fourth or fifth digits.

Skhūl X. Infant, about 5–5½ years; probably male. Represented by the symphysial part of the mandible containing three milk incisors, the unerupted crown of the left canine, four incisors, as well as the crown of the right canine. There is a fragment of the corpus containing first and second milk molars, and in addition to this there are the crowns of both upper permanent first molars. The crown of the upper permanent canine is also present. Of the skeleton there is only the lower half of the shaft and the distal end of the right humerus.

Isolated specimens from Mugharet es-Skhūl.

No. 1. Fragment of the left half of the mandible.
,, 2. Left patella.
,, 3. First left metatarsal.
,, 4. Central half of the diaphysis of a right tibia, female.
,, 5. Distal fourth of the shaft of a left tibia.
,, 6. Splinter of a shaft of a left tibia.
,, 7. Middle third of the shaft of a left femur.
,, 8. Middle fourth of the shaft of a left femur.
,, 9. Middle sixth of the shaft of a left femur.
,, 10. Middle portion of the shaft of a left femur.
,, 11. Fragment of parietal.
,, 12. Proximal part of a right humerus.
,, 13. Fragment of the distal part of the shaft of a right humerus.
,, 14. Splinter from the shaft of a left humerus.
,, 15. Distal part of the shaft of a right humerus.
,, 16. Small cranial fragment partially calcined.

SPECIMENS FROM MUGHARET ET-TABŪN

Tabūn I. A partially extended burial, about 30 years, female.

Skull: The vault of the skull was crushed. It has been reconstructed from about fifty pieces. The face is partially preserved, with a complete maxilla (right) and all the teeth except the left M–3.

Mandible: The coronoid process is defective on both sides and the condyle is missing on the right; otherwise complete.

Vertebrae: From the third to the tenth dorsal vertebrae, the fourth, fifth, and sixth being the best preserved.

Ribs: The first ribs on both sides are lacking, as are the twelfth pair, but there is some representation of all of the others in both right and left series, the bones of the left side being the best preserved.

Scapulae: The right bone is missing. The left includes the entire axillary border, the glenoid fossa with the acromion; defective coracoid. The remaining borders and the greater part of the spine are missing.

Claviculae: The right bone is represented by the sternal part with the damaged sternal articulation and there is also a fragment of the acromial end of the shaft. The left bone is represented by two fragments.

Sternum: Four fragments of the first, second, and fourth segments of the corpus. There is no trace of the manubrium.

Humeri: The left is complete. The right lacks the distal end of the shaft and the distal articulation.

Radii: Left complete; right missing.

Ulnae: Left complete; the right is represented by two fragments comprising the greater part of the diaphysis.

Hand: The left carpus is complete except for the os trapezium. The metacarpals are incomplete, but all are represented in part; the proximal phalanges of digits 1, 2, 3, the middle phalanges of digits 2 and 3 are present. The right wrist and fingers are missing.

Pelvis and Sacrum: The sacrum is absent. About half of the left ilium is preserved, with part of the acetabulum and the pubic ramus of that side. The crushed right acetabulum is accompanied by part of the ischial ramus. There is also the greater part of the right pubic ramus.

Femora: The right femur is almost complete but the distal end has been somewhat crushed. The left bone is so shattered and fragmentary that reconstruction was impossible.

Tibiae: The right bone is almost complete but the proximal end has been somewhat damaged. The left bone is nearly complete but the extremities have been crushed.

Fibulae: The right is complete except for the proximal end. The left is represented by fragments of the middle third of the shaft; other fragments represent the proximal end bearing the crushed head, and the distal extremity.

Foot: The left tarsus is incomplete, the talus being the only well-preserved bone. The right tarsus is complete. Both first metatarsi are preserved as well as the second to fifth metatarsals of the right foot. The base of the proximal phalanges of digits 2, 3, and 4, as well as the middle and distal phalanges of digit 3, are present.

TABŪN II. About 30–35 years; male. Represented by an isolated mandible. The specimen is intact with the exception of the left condyle and the left medial incisor.

Isolated specimens from Mugharet et-Tabūn.

Tabūn 1. The lower half of the shaft of a right femur, female.
,, 2. Distal fourth of a right radius, female.
,, 3. A right os hamatum.
,, 4. A right pisiform bone.
,, 5. Proximal phalanx of a left pollex.

Note: Nos. 3, 4, and 5 in colour and preservation are alike and may belong to the same individual. All come from Layer C.

Serial Specimens from Mugharet et-Tabūn.

Tabūn Series I: Fragment of an adolescent maxilla with alveoli for right incisors and canine. Belonging to this are the upper right teeth, I–2; C, Pm–1; Pm–2; M–1; M–2. This specimen came from Layer B.

Tabūn Series II: Unworn miscellaneous teeth, including upper left I–2; lower right I–2; upper right Pm–1; upper left M–1; the crown of upper right M–1. All of the specimens except the lower right I–2 (Layer B) came from Chimney II.

Tabūn Series III: Teeth showing various degrees of wear, consisting of an upper left I–2; upper left I–1; lower left M–1; lower right M–3. All of the specimens came from Layer B.

Tabūn Series IV: Milk-teeth; upper right i–1 (Chimney II); upper right and left m–2 (Layer B); a lower left m–2 (Chimney II).

Tabūn Series V: Miscellaneous teeth from Tabūn found in the superficial deposits of the Terrace and probably not Palaeoanthropic.

Tabūn E*a*: Fragment of a heavily mineralized, adult, right femur shaft extending from just below the neck to a point a little above the lower end of the shaft (from Layer E*a*, upper Acheulean).

Tabūn E*b*: Lower right M–1 or M–2, very worn with defective roots (from Layer E*b*, upper Acheulean).

The list of fossil specimens which we have given above will have acquainted the reader with such general facts as the extent of preservation, the sex, and the age of the various individuals. Before embarking upon a systematic description of the anatomy of these individuals, it will be well, before concluding this chapter, to recapitulate the chief facts bearing on their culture, climate, and antiquity. In another chapter (Chapter II) we shall give a brief synopsis of our conclusions regarding their physical characteristics and their relationship to known prehistoric races, and also to living races of mankind.

The Skhūl individuals were associated with a characteristic Levalloiso-Mousterian industry in a homogeneous deposit which filled the cave and terrace of the Mugharet es-Skhūl. The Tabūn woman and the man (Tabūn II) were found in an archaeological layer in et-Tabūn which yielded implements almost indistinguishable in type and in proportions from those of the Skhūl stratum. The maxillary fragment (Series I) and the isolated teeth (Series II, III, IV) come from Layer B, lying above Tabūn I and Tabūn II;

while the industry is also Levalloiso-Mousterian it shows certain developments which have led Miss Garrod (1937) to attribute to it a somewhat lesser age than that of Layer C.

Miss Bate's (1937) studies of the fauna from the Skhūl cave and from the long Tabūn prehistoric sequence are significant in two important respects as regards the fossil human remains. In et-Tabūn there is a sharp change in the character of the faunal census between Layers C and B. Not only are the proportions of the animal forms altered, but Layer B lacks certain species which are characteristic of Layer C and of the yet older strata (Layers D–F). As we have mentioned above, the flint industry shows an orderly change, and as far as our evidence goes, the human types which occupied the Tabūn remained essentially the same. Whatever were the factors that were responsible for the changes in the Palestinian fauna, they seem not to have affected the human population which dwelt in the Oven Cave.

Just as the artifacts indicate an identity of culture between the Skhūl deposit and the prehistoric layer in which were found the Tabūn man and woman, so the Skhūl fauna shows that this site was occupied before the time of the big faunistic change which is recorded in the history of the Tabūn cave. The Skhūl animals include species which are notable for their absence in Layer B of et-Tabūn and which are characteristic of Layer C. The outstanding difference between the faunas of the Skhūl and of the Tabūn is that in the former the most abundant of the animal remains consisted of the bones of wild oxen, while in the latter the most numerous were the bones of gazelles. There were ox remains in Layer C of et-Tabūn, just as there were gazelle bones in the Skhūl deposit. We have no ready explanation for this difference; what is convincingly clear is that we may speak of the Skhūl specimens as being contemporaneous in a moderately narrow sense with Tabūn I and II. Further, both the archaeological and the palaeontological evidence now at our disposal make it plain that the Skhūl people were antecedent to the various fragmentary individuals recovered from Layer B of the Tabūn cave. On anatomical grounds the latter appear to be later members of the human type which we know from our study of the skeleton of the Tabūn woman and of the massive male mandible.

CHAPTER II

THE RELATIONSHIP OF THE FOSSIL PEOPLE OF MOUNT CARMEL TO PREHISTORIC AND MODERN TYPES

BEFORE our readers proceed to study the detailed description of the remains of the fossil people from Mount Carmel which we have given in this work, it will be advantageous for them to know the chief conclusions to which we have come as a result of our prolonged investigation. These conclusions refer (1) to the relationship of one individual to another, and (2) to their relationships to other prehistoric peoples and to the living races of mankind.

In the earlier stages of our investigations we were inclined to believe we had before us the remains of two distinct types or kinds of humanity, the Tabūn and the Skhūl. The Tabūn type, represented by the complete skeleton of a woman (Tabūn I), the mandible of a man (Tabūn II), and some other fossil fragments, comes from the Mugharet et-Tabūn. The Skhūl type is represented by the complete skeletons of two adult males, the complete skeleton of a child, the incomplete skeletons of a male and a female, and the fragmentary remains of five other individuals (cf. Chap. I, pp. 2–8). We are persuaded that all the complete and the imperfect skeletons represent deliberate burials. As our investigations proceeded we encountered so many characters which linked the Skhūl to the Tabūn type that we were ultimately obliged to presume that we had before us the remains of a single people, the Skhūl and the Tabūn types being but the extremes of the same series. Yet the range in form, from that represented by Skhūl IV (male) to Tabūn I (female), is unexpectedly great. The Tabūn type possesses many features which link it to the Neanderthal type of Europe while the extreme Skhūl type passes towards a Neanthropic form such as that found at Cromagnon. Between these extremes are intermediate forms. All the members of the group possess certain characters in common, a list of which is given in our final chapter.

The chief consideration which moves us to regard all the specimens from both sites as members of the same species or race are: (1) their dental characters are uniform; we can draw no sharp line between the dentitions of the Tabūn and of the Skhūl people; (2) their cultures are very nearly identical; (3) they lived in the same locality at approximately the same period of time. On strictly anatomical grounds one would presume that the Skhūl was the later type. There is the same difference between the robust mandible of the Tabūn male and that of Skhūl IV or V as there is between the Cromagnon mandible and that of a modern Englishman—almost as great as between the Heidelberg mandible and that of the La Chapelle man. In size of palate the Skhūl men rivalled Neanderthal man, but in the form of their jaws, particularly of the mandible, there is evidence of certain retrograde changes. Miss Dorothea Bate has observed that the fauna represented in the Skhūl cave differs in certain details from that recorded for the Tabūn cave.

RELATIONSHIP TO GALILEE MAN

Our knowledge of the Galilean fossil people is based on part of a skull unearthed in 1925 by Mr. Turville Petre during excavations at the Mugharet ez-Zutteiyeh, about thirty-

five miles distant from the Wady Mughara. All that was found of the Galilee man (Keith, 1927)[1] were three bones of his skull, the frontal, the right malar, and part of the sphenoid.[2] A close comparison of these parts with the corresponding bones from Mount Carmel has convinced us that the Galilee and the Mount Carmel specimens should be regarded as members of the same group. His place is apparently towards the Tabūn extreme of this group.

The evidence which led us to this conclusion is worth considering by all who are concerned in the classification of extinct races, when only fragmentary fossil remains are available. The Galilean frontal, malar, and sphenoid bones were similar in their chief characters to the same bones of Neanderthal man. There were minor differences—the narrowness of the forehead and the height of the cranial vault. The fossil Galilean was regarded as a member of the species which is represented by Neanderthal man in Europe.

Now our investigations of the Mount Carmel people have shown us that in them it is just the bones found by Mr. Turville Petre, the frontal, malar, and sphenoid, that are most Neanderthaloid in their characterization. In the frontal of the Mount Carmel people we meet with the same narrowness and height as in the Galilee frontal, and we infer that had the rest of his skull and skeleton been found these parts would have possessed a series of characters similar to those of our Tabūn type. We may presume, provisionally at least, that in mid-Pleistocene times the people of Palestine were of the type or types described in this work.

VARIABILITY

We are of the opinion that the variability found amongst the fossil people of Mount Carmel is greater in degree and in kind than is to be observed in any local community of modern times. Had the Mount Carmel people been discovered—not collectively, in one place, but separately, in diverse localities, each excavator would have been convinced that a new and separate form of humanity had been unearthed, so great does one Carmelite individual differ from another.

How are we to explain the structural instability of the Mount Carmel people? Do they represent a people in the throes of an evolutionary transition and therefore unstable and plastic in their genetic constitution? Or is the variability due to hybridity, a mingling of two diverse peoples or races? We shall see that the Mount Carmel people represent a series which can be arranged between a Neanderthal form at one end and a Cromagnon form at the other. Is it possible that Neanderthal and Cromagnon—Palaeoanthropic and Neanthropic—stocks had met on the flanks of Mount Carmel in mid-Pleistocene times and that the fossil bones described here represent the progeny of their union?

We have given the supposition of hybridity our serious consideration and have rejected it. To win support for such a theory we should have to produce the fossil remains of a Neanthropic form of man in Palestine from a level as old, or older, than the Levalloiso-Mousterian of Mount Carmel, as well as the remains of a fully evolved Neanderthal form. We have no such evidence. All who believe in evolution are agreed that Neanderthal man and modern man are descendants of a common human stock. There must have been a

[1] See references to literature in the bibliography.

[2] A fuller knowledge of the sex differences in Palaeoanthropic races has led us to ascribe the skull to a man, not to a woman. Hrdlička came to this conclusion in 1930.

time in the history of that ancestral stock when individuals were undergoing differentiation along, at the least, two directions—towards the purely Palaeoanthropic (Neanderthal) type and towards a Neanthropic type represented by the early people of Cromagnon. We regard the tendency of the Mount Carmel people to diverge into two types as being due not to miscegenation but to an evolutionary divergence. We suppose that the Mount Carmel people were in the throes of evolutionary change.

RELATIONSHIP TO OTHER PREHISTORIC TYPES

Readers must not think that we look upon the Mount Carmel people as the actual stock which gave the world its Neanthropic or modern races on the one hand, and its Palaeoanthropic or Neanderthal races on the other. This is not our opinion. We can make our position clear by discussing the place which must be assigned to the Mount Carmel people among the prehistoric peoples of the Old World. Their relationship to the prehistoric peoples of the East—Sinanthropus and Pithecanthropus—is distant both in space and in time. Between them lies the whole width of Asia. It will be time to discuss how the peoples of the West stand to those of the East when the Pleistocene deposits which lie between Palestine and China have been explored and the cultural history of the intervening peoples has been unravelled. But in the Western world itself we know of at least five groups of prehistoric peoples with whom the Mount Carmel people may claim an evolutionary relationship. These five groups are (1) that found at Krapina in Croatia and so well described by Dr. Karl Gorjanovič-Kramberger (1906); (2) that found near Weimar in Germany and described by Prof. Franz Weidenreich (1928) and by Dr. Hans Virchow (1920).[1] To this group we would add the type described by Dr. H. Weinert (1936) from Steinheim-am-Murr in Württemberg; (3) the western Neanderthal group, found in France and the surrounding countries; the classical monograph on this group is Prof. Marcelin Boule's study of the La Chapelle skeleton (1911);[2] it is probable that this widely spread group was broken up into local types; (4) the Predmost people described by Prof. J. Matiegka (1925, 1929);[3] (5) the Cromagnon people of France described by Dr. René Verneau (1906).[4] The Cromagnon and the Predmost groups are Neanthropic in type and are the earliest representatives of the European, white or Caucasian races which have been discovered as yet.

RELATIONSHIP TO THE KRAPINA GROUP

The Mount Carmel people find their nearest affinities among the extinct groups of humanity available for comparison at Krapina. Both peoples—Mount Carmel and Krapina—are assigned to the same geological period, the latter part of the Riss-Würm interglacial epoch. The habitat of the Krapina people is nearer to that of the Palestinians than are the homelands of the other four types. Croatia is 1,400 miles from Palestine as the crow flies. At Krapina no complete skeletons were found, only fragments, but valuable fragments and in great number. There were no people at Krapina of the tall Skhūl type; all are small people, strong in jaw but relatively short and weak in limb. Indeed, in form of limb-bone there is much resemblance between the smaller specimens from Mount Carmel and those of Krapina. Neither at Mount Carmel nor at Krapina

[1] See also Keith, 1925, 1931.
[2] See also Boule, 1923; Morant, 1927, and Hrdlička, 1930.
[3] Morant, 1930; Keith, 1925, 1931.
[4] See also Morant, 1930.

were the thick massive femora and tibiae of western Neanderthal man represented. Nor do we find molar teeth of the taurodont type at Mount Carmel, a type so prevalent among the Krapina people, yet both people possess the same pattern in the crowns of their molar teeth. The crowns of the other teeth, too, are similar if we exclude certain individuals of the Skhūl type. The Krapina people had low-vaulted skulls, whereas the vault in the Mount Carmel people is of medium, even of great, height. The chin was developed to a variable extent in both the Krapina and the Mount Carmel people, but among the former never to the maximum degree shown by some of the Carmel specimens. It is our Tabūn type which makes the nearest approach to that of Krapina. In brief, the Krapina people, although they serve to bridge the gap between the ancient Palestinians and the Neanderthalians of western Europe, have their chief affinities with the latter group.

RELATIONSHIP TO THE EHRINGSDORF PEOPLE

The Ehringsdorf group, like that of Mount Carmel and Krapina is assigned to the Riss-Würm interglacial period and is therefore earlier in date than most members of the Neanderthal group of western Europe. Our knowledge of the group is limited to a skull and two mandibles. The skull is frankly Neanderthal but has three peculiar features which are worthy of note because they are met with in the Mount Carmel people: a relatively high vault, a neanthropic mastoid process, and an incipient external occipital protuberance. Apparently the Ehringsdorf type will find its closest resemblances with the Neanderthal people of western Europe.

Of the Neanderthaloid skulls of central Europe, that which bears the closest resemblance to the Palestinian type is the Steinheim cranium described by Weinert (1936, 1937). That writer ascribes this fossil specimen, which is one of the most complete of the mid-Pleistocene series yet discovered, to post-Riss times or to an early phase of the Riss-Würm interglacial. It is the skull of a woman and in many points resembles the skull of the Tabūn woman. In the meantime it may be included in the Ehringsdorf group, for it may well be the female form of this group. The molar teeth differ from those of the Tabūn woman. It is a remarkable fact that the Steinheim skull, which seems to be the earliest representative of the Neanderthal type so far discovered in Europe, should show so little of the occipital characterization found in specimens of later date, and should, in its occipital characters, make an approach to the Palestinian type.

RELATIONSHIP TO THE NEANDERTHAL GROUP OF WESTERN EUROPE

Our conception, hitherto, of the Neanderthal type or species has been based upon the fossil remains found in central and south-western Europe. The man of Düsseldorf and the man of La Chapelle-aux-Saints best represent the male form of this group. They were squat, strongly built men who differed from living types of mankind in almost every detail of bodily structure. Many points in their anatomy recall those found in the anthropoid apes, particularly in the gorilla. This type—the Neanderthal of Europe—is not found among the Mount Carmel people. Our Skhūl men are tall; their lower limbs were long and straight; the long, straight, heavily pilastred Skhūl femur differs altogether from the short, bowed Neanderthal femur, with its massive articular extremities. The feet of the Mount Carmel people were moulded and used as ours are. Like Neanderthal man, the Skhūl men were big-brained, but the moulding of their head and jaws was modern

And yet, through the anatomy of the Mount Carmel people there runs a substratum of characters which link them to the Neanderthal type. We have mentioned that the individuals described in this study can be arranged in a series with the Tabūn type, plainly Neanderthaloid, at one extreme and the Skhūl type at the other. Similarly the groups of fossil man just enumerated can be arranged in a series with the Neanderthal group of western Europe at one extreme and the Mount Carmel group at the opposite extreme. It does now seem probable that western Europe, in the middle phases of the Pleistocene period, had become an evolutionary backwater so far as humanity was concerned and that the centres of active evolutionary progress lay much farther to the east, probably in western Asia.

RELATIONSHIP TO THE PREDMOST PEOPLE

The Predmost people are the earliest representatives of the Neanthropic type of man that have been discovered in central Europe. The men have certain primitive characters, such as their prominent supra-orbital ridges, but in general structural characterization they are Caucasian. There are resemblances between them and the Skhūl men which deserve mention. The Predmost man (No. 3) has supra-orbital ridges which, although falling short of the development seen in Skhūl IV, serve as a link between that of Skhūl and of the development found in some modern Europeans. In shape, size, and characterization of their skulls, the Predmost and the Mount Carmel people had many points in common. But the Predmost people are of medium or short stature and are devoid of the Neanderthaloid features of the Skhūl people. Their relationship to the Mount Carmel people is more remote than that of the Neanthropic group we are now to discuss.

RELATIONSHIP TO THE CROMAGNON GROUP

If only the limb-bones of the Skhūl people had been discovered at the Wady Mughara, we have no doubt of the verdict that anatomists would have passed on them. They would have declared that they were the fossil remains of a Neanthropic race, near akin to the Cromagnon people, the people who appeared in Europe towards the end of the Pleistocene period. Because of their crude characters and seeing how much the Skhūl people antedate the Cromagnons of Europe, these fossil limb-bones would have been accepted as evidence of the existence of proto-Cromagnons in mid-Pleistocene times. Or let us suppose that only hands, or feet, or the hinder part of the skull, or the auricular region carrying the joint for the mandible, or the lower jaw itself had come to light; the verdict would have been the same. These parts would have been accepted as evidence of the existence of a Neanthropic race. On the other hand, if it had happened, as it did in the case of the Galilee discovery, that only the anterior part of the skull of the Mount Carmel people had been recovered, then the verdict would have been Neanderthal. Most of the teeth, a study of the vertebrae, or of the ribs would have led to the same conclusion: that they must be ascribed to a Neanderthaloid race. Even in the case of the ribs the evidence would have been equivocal for both forms of ribs occur at Mount Carmel, the rounded Neanderthal form and the wide-bladed ribs of Neanthropic man.

Of the early Neanthropic types known to us, there can be no doubt as to the one which comes nearest that of our Skhūl people. It is the Cromagnon type of southern France, the cave-dwellers of the Aurignacian. The Skhūl men, like the male Cromagnons, were

tall; their stature ranged from 5 ft. 6·7 in. (1,700 mm.) to 5 ft. 10·3 in. (1,787 mm.). The bones of their lower extremities, from hip-joint to toes, are very similar to those of the Cromagnon men. So it is as regards the bones of the upper extremity, save that those of the Cromagnon males are more robust. But although what we have said of the bones of the upper and lower extremities is true of most of the Skhūl men, it is not true of all. Some have bones exhibiting certain Neanderthal characters to a greater or less degree.

A critical survey of the bones of the pelvis, shoulder, and trunk of the Skhūl males yields a mixed list of characters, Neanderthal, modern, and some which are neither; the latter appear to be peculiar to the Skhūl type. These features of the pelvis and the clavicle are duly described in their respective chapters. An examination of the skull gives the same mixed result. On the whole, characters of a Neanthropic nature are dominant to those of a Neanderthal kind. The Skhūl men had more rugged faces than the Cromagnons. Their brow-ridges formed continuous, prominent, bony ledges above the orbits; their noses were wide, their jaws large, and their chins under-developed to a varying degree. Certainly in the extreme Skhūl form (represented by Skhūl IV) the Cromagnon predominates over the Neanderthal characters.

Dr. Aleš Hrdlička[1] may now claim that the presence of a proto-Cromagnon type among the cave-dwellers of Mount Carmel is a confirmation of the theory he advocated in his Huxley Lecture of 1927, namely, that the Neanderthalians of Europe did not become extinct, but in the course of a rapid evolution became transmuted into modern man. Dr. Hrdlička believes that evolution was speeded up under the pressure of a growing arctic environment. Palestine lay beyond the ice-sheet and we cannot invoke glacial conditions to account for the evolutionary state of the Mount Carmel people.

It might be asserted that the right interpretation of the state of affairs found among the Mount Carmel people is very simple: that Neanderthal man is there being transformed into modern man of the Cromagnon type. This certainly is a simple explanation and a possible one, yet it does not seem to us to be the most probable.

In the first place, it is to be noted that the Neanthropic type which is making its appearance amongst the Skhūl people is a very particular form of modern man, one of the white or European type, for concerning the racial status of Cromagnon man there should be no doubt. All his features are European, Caucasian, or white. Our belief is that at Mount Carmel we have reached a transitional zone which leads from one ancient area of racial differentiation (the Neanderthal or Palaeoanthropic) to another ancient area lying farther to the east, a Neanthropic area where the proto-Caucasian (or proto-Cromagnon) type of man was being evolved. The evidence is now convincing that in mid-Pleistocene times the inhabitants of Europe—of the continent at least—were all Neanderthal in type, but we have seen that the type becomes modified as we proceed from west to east and that in Palestine we find a transitional type leading towards the Neanthropic type. It seems logical to us to assume that when the wide tracts of western Asia of mid-Pleistocene times are entered we shall find ourselves in the homeland of the proto-Caucasian. Eastern Asia we regard as the evolutionary cradle of the proto-Mongols. Our theory therefore assumes that the Mount Carmel people are not the actual ancestors of the Cromagnons but Neanderthaloid collaterals or cousins of the ancestors of that type. We expect that the fossil remains of the real proto-Cromagnons will be discovered still farther to the east.

[1] Hrdlička, 1927.

Our hypothesis helps us to explain many events in the history of mankind in the western part of the Old World. If we assume that a progressive and conquering type of humanity was being evolved in western Asia in the remote times at which the Mount Carmel peoples lived, and that as their tribes increased in numbers and in strength they pushed continually westwards, replacing and extinguishing the native Neanderthalians, then we can give a reasonable explanation of the discoveries made by prehistorians and anthropologists in the late Pleistocene burials of Europe. Before the dawn of history western Asia served as a nursery for Europe, sending out peoples, cultures, and tongues. If our theory is well founded, then we must assume that this relationship between the two continents goes back to the remote times in which the Mount Carmel people lived. In brief, our theory assumes that Europe became the 'Australia' of the ancient world after mid-Pleistocene times and that the people who colonized it and extinguished its Neanderthal inhabitants, as the whites are now ousting the 'blacks' of Australia, were Caucasians evolved in western Asia.

THE PLACE OF THE MOUNT CARMEL PEOPLE IN A SCHEME OF CLASSIFICATION

We feel that a knowledge of the mid-Pleistocene races of the western world has now reached a point which makes necessary a revision in the nomenclature and in the scheme of classification of fossil man. The earliest and the most primitive trace of the Neanderthal type in Europe is the Heidelberg mandible. Bonarelli (1909) proposed the generic name Palaeoanthropus for Heidelberg man, and it seems to us advisable to use this name as a generic designation for all forms of humanity which show a predominance of Neanderthal characters. We arrange our specific groups as follows:

1. *Palaeoanthropus heidelbergensis* (Heidelberg Man).
2. *P. ehringsdorfiensis* (represented by the fossil remains found near Weimar).
3. *P. neanderthalensis* (as represented by the Düsseldorf specimen and that of La Chapelle-aux-Saints).
4. *P. krapinensis* (represented by the fossil remains from Croatia).
5. *P. palestinensis* (the Mount Carmel and the Galilee remains).

CHAPTER III

THE FOOT

THE FOOT AS A WHOLE

BEFORE proceeding to describe the individual bones we propose to give a brief review of the main results we have reached by a study of the foot as a whole. Never before have complete skeletons of the feet of middle Palaeolithic man been available for study. We are fortunate in having two intact specimens—the right foot of the small but interesting woman, Tabūn I, and the left foot of Skhūl IV—a tall, robust man. We built up these two feet on plasticine supports, being guided, in placing and adjusting the bones, by the fit of their inter-articular surfaces. Side by side with these we built up two other feet—that of a Bushman for comparison with Tabūn I and that of a Sikh, whose stature falls only a little short of Skhūl IV.

Of these four feet we made exact drawings, first as viewed from above, i.e. at right angles to the plane on which the sole of foot rested (Fig. 1 A, B, C, D; Pl. II); second, as viewed on the medial aspect, at right angles to the sagittal plane of the foot (Fig. 2 A, B, C, D). These drawings were used for estimating the absolute and the relative lengths of the tarsal and metatarsal elements. A point on the middle of the posterior margin of the heel (tuber calcanei) was the base from which measurements were taken. The length of the tarsal element was measured from this point to the mid-point of the articulation of cuneiform II with the second metatarsal; the length of the second metatarsal, measured from the point at its base just mentioned to the mid-point on the anterior articular convexity at the distal end. The width of the foot was taken with calipers from the mid-point on the medial margin of cuneiform I to the mid-point on the lateral margin of the cuboid.

The length of foot in these fossil people is in no way remarkable. Measured in the manner just mentioned, the total length of the foot in Tabūn I (a small woman) is 222·0 mm. as against 215·0 mm. for a person of about equal stature (cf. Table I). But she was relatively wide-footed, the breadth, 60·0 mm., being 27 per cent. of the length. The breadth in the Bushman was 54·0 mm., this being 25·1 per cent. of the length. In the Sikh the length of the foot is 239·0 mm.; its width, 66·0 mm., is 27·6 per cent. of the length. Skhūl IV has about the length we expect in a modern man of his stature; the foot is longer and narrower than in the Sikh. Its length is 256·0 mm. (17·0 mm. more than in the Sikh), while its width, 61·0 mm., was 5 mm. less, giving a breadth index of 23·8. Thus, of the feet compared, one an ancient (Skhūl IV) and the other a modern (Bushman), the foot was relatively narrow, while in the remaining two, Tabūn I and the Sikh, the foot was relatively wide. In ancient as in modern times we meet with variability in human feet, both as regards length and as regards breadth.

One of us (A. K.) observed many years ago that if we derive the human foot from an anthropoid prototype, then the chief change in the transformation of the anthropoid into the human form has been in a reduction of the grasping digital element of the anthropoid foot and an increase or hypertrophy of its tarsal or supporting element. Of the three elements which make up the length of the foot, tarsal, metatarsal, and digital, the metatarsal

is the least changed of the three, is the more constant. In the present investigation, as already explained, the distal margin of the mid-cuneiform is taken as the distal limit of the tarsus; the length of metatarsal II represents the length of the metatarsal element, while the three phalanges of metatarsal II represent the digital element.

The actual and relative sizes of the three elements of the foot are given in Table I, p. 34. In both ancient feet the tarsal element is short relatively and absolutely, 2 or 3 per cent. shorter than in the modern examples chosen for comparison. The digital element in both fossil feet is longer, both absolutely and relatively, than in the modern feet—with one strange exception. In the Sikh foot the metatarsal element is peculiar. Metatarsals I, II, III are all of equal length and all relatively short for such a foot. For instance, the second metatarsal in Skhūl IV is 78 mm., in the Sikh only 65 mm. Thus the digital element becomes relatively great in the Sikh, namely, 24·8 per cent., while it is only 23·8 per cent. in Skhūl IV, because of the absolute length of the metatarsals. In reality the phalanges of digit II in Skhūl IV measure 59 mm., while in the Sikh—nearly equal in stature—they measure only 51 mm. Thus we may hold it as proved that as regards these ancient people from Mount Carmel the tarsus is relatively shorter and the toes relatively longer than in modern man.

We now proceed to discuss the relative length of the five digital elements of the foot. With this discussion is related another matter, the transference of size and power from the third digit to the second in the outer digital series, as contrasted with the inner or hallucial element of the grasping foot. In the chimpanzee and the gorilla the third toe is the best developed of the outer series although there is, in the gorilla, a tendency towards the second. This transference has taken place in most gibbons, digit II being the strongest of the outer series. The transference from III to II has taken place in both the fossil feet we are describing; it is so in all four feet, both ancient and modern, but in varying degrees. For example, the proximal or basal end of metatarsal II is rather stronger and more massive than that of metatarsal III. In all the specimens the head or distal end of metatarsal II is the wider and more massive. The shaft, too, is rather thicker and stronger (Table VIII, p. 38).

Another of the evolutionary changes which accompanied the transformation of the anthropoid foot was an increase in length and strength of all the elements of the hallux. In the fossil feet under review the hallucial element remains relatively short. Unfortunately we did not succeed in finding the phalanges of the big toe of Tabūn I; we have to base our statements on the dimensions of the metatarsal element (Table I, p. 34). The measurements given in this table show the hallucial element as being only 90·6 per cent. of the second metatarsal element. In Skhūl IV the hallucial element is somewhat more—95·4 per cent. In the two modern feet, Bushman and Sikh, the hallucial element is about equal to metatarsal II.

When we inquire as to the state of the other digital elements, III, IV, and V, we find that in the Mount Carmel people there is no decided and constant difference; the individual variability is also very high. The degeneration in the fourth and fifth digits of Tabūn I has gone farther than in the Bushman.

When describing the state of the toes in these ancient people (p. 32) we shall have occasion to point out that the middle phalanx of the toes has undergone severe reduction in the outer three toes (III, IV, V) in all modern races, and to a certain extent this has

also happened to the middle phalanx of II. In Skhūl IV, on the other hand, degeneration has not overtaken the mid-phalanges of II and III to the extent seen in the feet of modern native peoples. Unfortunately we can make no definite pronouncement as regards Tabūn I; the mid-phalanx of II still retained its original form, but whether this was so or not in III we cannot say.

The foot of Tabūn I seems to us to represent an older or more primitive form than that of Skhūl IV. The latter makes a nearer approach to the modern form. The differences between the foot of the Bushman and that of Tabūn I are more apparent than are those between the Sikh and Skhūl IV (Figs. 1, 2). It will be noted in the drawing of the foot of Tabūn I that the metatarsals radiate out from the tarsus, as in the foot of an infant, whereas in the Bushman the lateral digital series have turned medially towards the hallucial element.

In the course of describing the individual bones we shall have occasion to touch on other peculiarities of the ancient foot. It will be remembered that M. Boule, in giving his classical account of La Chapelle man, published figures that represent the state of the heel and the foot in that ancient individual as intermediate in certain respects between man and ape. There is no trace of this in the feet examined by us. The heels are stout, compact, and short and perfectly upright. With such short heels—which serve as levers for the muscles of the calf—we infer that the ancient Palestinians, like the white- and yellow-skinned stocks of modern humanity, had legs provided with ample calf muscles.

The degree to which the foot was arched is made evident in the profile drawings (Fig. 2 A, B, C, D). The arch was just as well developed in the ancient Palestinians as in modern races. In Tabūn I and in the Sikh, the talus seems to form the apex of a high arch, whereas in Skhūl IV and the Bushman it is lowly placed, as if the arch had collapsed. In both of these feet it will be noticed that a large area of the head of the talus is exposed —as if these two feet were unduly everted. We can assure the reader that this was really not so; the difference between the talus of Tabūn I and of the Bushman is very apparent in Fig. 2 A, B. Neither do we find that the hallux shows evidence of greater mobility in the ancient race. It is true, as we shall see later, that the joint between metatarsal I and cuneiform I retains the saddle-shaped form more perfectly than do the corresponding bones in modern races, yet in every respect the hallux of the ancient Palestinians was human. The Palestinians were human in their posture and gait so far as the evidence of the foot bears on these problems.

THE TARSUS

TALUS (Pl. III; Figs. 3, 4, 5)

We have seven specimens of this bone, namely, Tabūn I, right and left; Skhūl IV, right, left (imperfect); Skhūl V, left; Skhūl VI, left;[1] Skhūl VII, right (imperfect). There are thus three specimens from the right side, four from the left.

The bones fall into three groups: (*a*) the massive male type, Skhūl IV, V; (*b*) male but longer and narrower, represented by Skhūl VI; (*c*) a small female type represented by Tabūn I, Skhūl VII. It is the first group that is comparable in point of size with

[1] This specimen was impossible to free from its matrix-bound articulation with the incomplete calcaneus, navicular, and cuboid.

European Neanderthals—such as La Chapelle and Spy. Unfortunately a direct comparison with Boule's specimens is rendered difficult because he followed the method devised by Volkov, whereas we have adopted the more generally accepted methods and measures described in Martin's *Lehrbuch*. Martin gives the width of talus in native peoples as varying from 77 to 82 per cent. of the length; as will be seen from Table II, the width in the Palestinian tali varied from 77·5 to 85·1 per cent. of the length, a range easily within the modern. The mean for the six complete specimens is 81·1 per cent. To convert Martin into Volkov results about four points have to be added, giving a mean of about 85 per cent. for the Palestinians. M. Boule gives a mean of 87·1 per cent. for the European Neanderthals (based upon five specimens). We have worked out, following Volkov's method, results for Skhūl IV (88·3), for Skhūl V (87·2), Tabūn I (80·7), Skhūl VI (81·2). Thus our male group give absolute measurements nearly as great as those of La Chapelle and Spy, yet they are relatively narrower. It will be observed (see Table II, p. 35) that the Krapina specimen, like ours, is relatively narrow.

As regards the relation of height to length, there is no great difference to be observed between the Palestinians and the Neanderthal people of Europe or with modern native peoples. Martin gives a range for the length-height index of 56·8–60·8 per cent. In the Palestinians the range (see Table II, p. 35) is 56·8–66·6 per cent.—a range showing a preponderance of high bones. The mean for the series is 60·2 per cent.—nearly two points above the mean for modern native peoples. In Krapina, as in Skhūl VI, the talus is relatively low. In La Ferrassie the talus was high—66·6 per cent. estimated according to the Martin method of measuring relative height.

Thus there is nothing racially diagnostic in either the absolute or relative measurements of the talus. To distinguish the bone of the Palaeoanthropic group—in which we include the Palestinians—we have to depend upon the following anatomical markings:

A. The presence of a sharply cut and deep sub-capitular pit or fossa (Fig. 3, *pit*) on the under-surface of the talus. The fossa is below and behind the head of the talus, opening on the distal wall of the calcaneal sulcus. It is for attachment of a strong band of the interosseous ligament. We found the fossa best marked among living peoples in the Bushman, but to a lesser extent than in the Palestinians. In the modern bone this fossa has become filled up; it is well marked in the gorilla (Fig. 3 C).

B. The upper or dorsal margin of the articular head of the talus has a peculiar form. The peculiarity will be understood by consulting Fig. 4, where the anterior aspect of the left talus of Tabūn I is compared with the same aspect of the Bushman talus. Both bones rest on the same plane. It will be noted that the upper border of the head in its medial part is evenly convex in Tabūn I. A definite ridge of bone runs from the medial malleolar facet of the trochlea along the neck of the talus (Fig. 4 A, *x*). In the Bushman bone the head and neck in front of the medial malleolar facet are seen to be flattened, there being no pre-malleolar ridge. This ridge and elevation are present in all our Palestinian specimens and are also present in the Krapina talus. It is this addition to the upper and inner aspect of the capitulum which gives its articular surface a more rounded form in the Neanderthal talus.

C. When the Palestinian talus rests on its under-surface the medial and lateral margins of the trochlea are almost at the same level. If there is a difference, it is the medial margin that is the higher, whereas in modern bones it is the opposite that is the case.

European Neanderthals also have tali with medial and lateral margins nearly level; in apes the lateral margin is much the higher—an adaptation for turning the sole of the foot inwards. Thus, in the Palestinians, as in the Neanderthalians of Europe, the talus has moved farther away from a simian state than is the case in most modern races, for one does encounter modern tali in which the lateral margin is the lower.

D. The greater extent of the hinge-movement of the tibia on the talus—both for dorsiflexion and for plantar-flexion. This is indicated by the prolongation of the articular surface forwards to the neck in front and backwards to the medial tuberosity of the talus. In native peoples the anterior margin of the tibia comes in contact with the dorso-lateral aspect of the neck of the talus; in the Palestinians, as in the Neanderthalians of Europe, nearly the whole of the upper surface of the neck comes in contact with the tibia, so that it is difficult to define the anterior margin of the trochlear surface. In Skhūl IV the trochlear convexity or arch (measured along the mid-sagittal plane) has a base-length of 35 mm. and a vertical height of 12 mm. The corresponding measurements of the Sikh trochlea are 34 mm. and 10 mm. The same measurement made in Tabūn I gives a length of arch of 30 mm. (26 mm. in the Bushman) with a vertical height of 9 mm., as compared with 8·5 mm. in the talus of the Bushman.

E. The concavity and projection of the articular surface for the lateral malleolar process. This, as will be seen from Table II, line 9, is 2 mm. greater than in most modern individuals, although it will be noted that the lateral projection in the Bushman is 2 mm. more than in Tabūn I. The Bushman is remarkable for the great development of the external malleolar process of the fibula and the corresponding part of the talus. The apex of the lateral malleolar surface not only projects widely but is deeply concave to receive the convexity of the lateral malleolus. Comparing these lateral malleolar areas of the Sikh and Skhūl IV, we note that in both cases the apex of the area is the same distance from the base (formed by the lateral margin of the trochlea), namely, 24 mm., but the depth of the concavity in Skhūl is 5 mm. whereas in the Sikh it is only 2 mm. The extensive concave lateral malleolar area is a simian feature. Nevertheless, as will be seen by comparing the talus of Tabūn I with that of the Bushman (Fig. 4), the external malleolar mass of the latter is much greater than in the former.

F. As will be seen in Fig. 3, the medial tuberosity is massive in the gorilla, and this is so in the Palestinian and in the Neanderthal talus. Yet in that of the Bushman this tuberosity is larger than in Tabūn I (Fig. 3).

G. In the anthropoid talus, as in that of the new-born child, the neck of the talus is bent inwards, forming an angle with the sagittal axis of the trochlea. M. Boule has emphasized the degree of inclination of the neck as a mark of the Neanderthal talus. As will be seen from Table II, line 18, the nuchal angle varies greatly in the Palestinian, ranging from 18° to 28°, whereas the angle in the Sikh is 32°, that of the Bushman 35°, both being greater than in the fossil specimens. The mean angle for Europeans is only 17·8°, in Spy II 25°, in La Chapelle 23°, and in La Ferrassie 30°. Thus the angle of the neck has no diagnostic significance.

H. The angle which the axis of the articular head makes with the horizontal plane is given in Table II, line 19. This angle in European Neanderthalians varies from 28° to 32°; in the Palestinians from 29° to 40°; in modern Europeans the mean is 40°; in anthropoids the range is from 24° to 28°. Thus, in the Palestinians this angle has passed farther

from the anthropoid angle than in the Neanderthalians of Europe. This, no doubt, is due to the addition made to the upper circumference of the head (see Fig. 3).

I. The proportion which the head and neck form to the total length (Table II, p. 35) is low. In the Palestinians the proportion varies from 25·5 to 36 per cent.; in the Bushman it is 39·5 per cent.; in the Sikh 37·7 per cent. The shortness of the neck is due to the forward extension of the trochlear surface. The proportions in Skhūl IV are those seen in La Chapelle man. Thus, although there is a remarkable range in the absolute measurements and proportions of the tali of these Palestinians, there is a constancy in their anatomical markings which should serve to distinguish even a single specimen from that of modern man.

CALCANEUS (Pl. III; Figs. 5, 6)

Our excuse for giving so full a descriptive account of this bone, and of the last, is that hitherto so few complete specimens have been available. Of the calcaneus we have seven adult specimens—two right (Tabūn I, Skhūl IV) and five left (Tabūn I, Skhūl IV, V, VI, VII). Of these the left of Tabūn I and of Skhūl V, VI, VII are imperfect. They fall into two groups: Tabūn I and Skhūl VII, small and feminine; the rest male and massive. So far as published accounts permit us to judge, the calcanei of La Chapelle and La Ferrassie were slightly more massive than our male series but apparently were similar in their anatomical characteristics save that, so far as the heel itself is concerned, there are no outstanding simian features such as have been described by Boule.

As regards the proportion of width to length, we find a range running from 53 per cent. in Skhūl IV to 55·7 in Tabūn I (Table III A, p. 35). In the Bushman used for comparison with Tabūn I the width ratio is 56·3 per cent.; in the Sikh 57·9 per cent.; in La Chapelle man it was 58 per cent. Thus, there is no racial distinction in this ratio. There is, however, a greater difference if we compare the least width (Table III A, p. 35) with the greatest length. The mean for Europeans is 35 per cent.; in the Bushman calcaneus it is 32; in the Sikh 40·8; in Skhūl IV 36; in Tabūn I 38·5. The Neanderthalian calcaneus is thick from side to side. As regards the relation of the height to the length, we find the same variability (Table III A); it runs from 50·7 per cent. in Tabūn I to 56·8 per cent. in Skhūl IV. The mean for Europeans is 52, in the Bushman it is 46·5, and in La Chapelle man 52·5.

We turn now to the length of the heel, which represents the lever acted upon by the muscles of the calf of the leg (Table III A). The heel is long in the Bushman as in most African natives, being 45·8 per cent. of the total length of the bone. In the Sikh it is relatively short, namely, 40 per cent. It is short in the Palestinians—40 per cent. in Tabūn I, 40·7 and 42·6 per cent. in Skhūl IV. It appears really shorter than it is, as may be seen from Fig. 6 B, this appearance being due to the fact that in the Palestinians the tuber calcanei slopes forwards more as it ascends than is the case in modern man. A short heel is not an anthropoid feature; the opposite is the case and we shall find several ultra-human characters in the Palestinian calcaneus. This is also seen when the diameters of the tuber calcanei are compared (Table III A). The tuber is relatively and absolutely wide.

In his justly famed monograph on La Chapelle man Boule included a drawing of the heel seen from behind; the drawing shows the heel of Neanderthal man occupying a

position between that of the anthropoid and of modern man. In Fig. 5 we produce four similar drawings; the heel region of Tabūn I is compared with that of a Bushman, Skhūl IV with that of a Sikh. In the Sikh the vertical axis of the tuber cuts the astragalus and emerges near the mid-point of the trochlea; so, too, in Tabūn I. In the Bushman it emerges almost at the lateral border and the axis of the heel in Skhūl IV is much as in the Bushman. In this point the Palestinians are altogether modern.

If we consider the degree to which the internal tuberosity has developed in size and the extent to which it has merged with the lateral tuberosity to form the human heel, the Palestinians may be said to be ultra-modern. This will be made clear to the reader by the series of drawings in Fig. 6. The upper figure (Fig. 6 A) represents the lateral aspect of the right calcaneus of a gorilla. On this aspect of the calcaneal lever is seen the lateral tuberosity; it is connected in front with the peroneal tubercle by a ridge. In Skhūl IV (Fig. 6 B) the tuberosity has moved downwards and backwards to fuse intimately with the greatly overgrown internal tuberosity. The ridge which connects it with the peroneal tubercle is still plainly visible, as is also the case in the Bushman. In the Sikh (Fig. 6 C), however, as in most European calcanei, the ridge has disappeared. In the drawings reproduced in Figs. 5, 6, it will be seen that the lateral tuberosity has fused to a much greater extent in the Palestinian calcanei than in the modern specimens.

The sustentaculum is large in Neanderthal man; in the Palestinians, as may be seen from the measurements (Table III B, p. 36) and from the drawings of the calcaneus in Figs. 5, 6, it varies in size. In Skhūl IV it is massive, wide, and thick; in Tabūn I it is of moderate size—well within the range for modern women.

The anterior articulation, which supports the head of the talus, covers the upper surface of the sustentaculum. The dimensions of this articulation are given in Table III B; it is exceptionally long in the Palestinian calcaneus and in all the specimens the two areas are quite continuous, whereas in the specimen described by Boule the two areas were semi-divided as is so often the case in modern calcanei. The depth of the concavity of the anterior facet was 4·6 mm. in Tabūn I, 7·4 mm. in Skhūl IV, 4 mm. in the Krapina fragment, 5 mm. in the Bushman, and 5 mm. in the Sikh. It is the length rather than the width which is the outstanding feature in the sustentaculum tali of Palestine man. In the posterior articular area, for articulation with the talus, we found no characteristic marking. Its dimensions and inclination are given in Table III B. All its dimensions are variable.

The remaining articulation which requires mention is that for the cuboid (see Fig. 6 A′, B′, C′). The dimensions and shape are not greatly different from those of modern man. There is a tendency for a greater preponderance of the vertical diameter (Martin's 12) which is an anthropoid feature, yet, strange to say, the cuboid facet on the calcaneus of the Bushman is relatively wide.

As in modern man, the cuboid articular surface is saddle-shaped, concave from above downwards, and convex from side to side. The concavity is very great in the Palestinian calcaneus owing to the forward projection of the sustentacular border. The depth of the concavity in Skhūl is 3·8 mm., the transverse convexity 5 mm. The corresponding measurements in Tabūn I are 2·6 mm. and 3 mm.; in the Sikh 2 mm. and 3 mm.; in the Bushman 1 mm. and 3 mm. The medial margin of the cuboid articulation lies in a depression and is placed distal to the lateral margin. The amount that the medial margin is

placed behind the lateral is 12 mm. in the Bushman, 9 mm. in Skhūl IV, 8 mm. in the Sikh, and only 3·5 mm. in Tabūn I. The extent and shape of the articulation show that there was very free movement between calcaneus and cuboid in the Palestinians.

The view of the calcaneus from above, reproduced in Fig. 1, shows that the retro-articular part of the bone—the heel—is bent inwards. The outer border shows a blunt angle between the body and the heel. Measurements made directly on the bone, when compared with others, were found to show that this bending inwards of the heel was within the range occurring in modern man.

OS NAVICULARE (Pl. III; Fig. 7)

There are five examples of this bone: the right and left of Tabūn I; the right and left of Skhūl IV; the left of Skhūl VI.[1] In Table IV (p. 36) their measurements are given, together with that of a Bushman (for comparison with Tabūn I) and with that of a Sikh (for comparison with Skhūl IV). In the literature we have found a descriptive account of only one specimen—that given by Kramberger for a Krapina example.

Hitherto, when comparing the bones of Tabūn I (a female) with those of a Bushman, an approximate equality in dimensions has been obtained, but in the case of the os naviculare the dimensions of the fossil bone preponderate—as will be seen when the drawings of the feet are compared (Fig. 1 A, B). As may be noted in the table of measurements (Table IV, p. 36), as well as from an inspection of these drawings, the fossil bones are thicker in their antero-posterior diameters—especially those towards the medial margin or tuberosity.

An examination of the measurements will show that there is no constant difference in the relative dimensions of the ancient and modern bones. But there is a difference as regards the development of the tuberosity of the bone. This difference is made evident in Fig. 7 A, B, C, where the dorsal aspect of the os naviculare of a chimpanzee, Tabūn I, and a Bushman is seen. The development of the tuberosity in an inward direction may be measured by the amount by which the total width of the bone exceeds the total width of the proximal articular facet. In a chimpanzee the difference is 8 mm.; in Tabūn I it is 10·8 mm.; in the Bushman 8 mm.; in Skhūl IV 12 mm.; in the Sikh 11·5 mm. As will be seen from Table IV, the tuberosity in Tabūn I is exceedingly great in its antero-posterior diameter and is shaped as in the chimpanzee (Fig. 7). In point of development the tuberosity of the Sikh is nearly as great as in Skhūl IV, and yet on inspection the latter seems the more massive.

In Fig. 7 D, E, the anterior surface, bearing the cuneiform articulation, of the os naviculare of Skhūl IV is compared with that of the Sikh, while in A, B, C, the dorsal aspect of the bones of a chimpanzee, Tabūn I, and a Bushman are represented, in which the direction of the three cuneiform articulations are indicated. When the three dorsal views are compared, the anthropoid features of Tabūn I are very evident. In the chimpanzee the articulation for cuneiform I is markedly convex in all directions. This is also the case, but to a less extent, in Tabūn I. The convexity is also present in Skhūl IV and in the Sikh. When the drawings D, E, are compared it will be seen that in the modern bone (the Sikh) the first cuneiform area has extended itself outwards at the expense of cuneiform area II; also that in the fossil bone this area has extended itself downwards on to the base

[1] See note on p. 21.

of the tuberosity. The drawings B and C bring out a very important point: the anterior and posterior articular surfaces are nearly parallel in the os naviculare of the Bushman, whereas in Tabūn I the posterior surface diverges backwards as it reaches the tuberosity. The result is to give the anterior surface of the fossil bone, when articulated as in Fig. 1, a less inward (anthropoid) direction. In Fig. 7 D, in the interosseous area, just under the cuneiform articulation, a tubercle is indicated—the plantar tubercle. This is usually present in modern man but is absent in Skhūl IV and also in the Bushman.

It will be noticed (Fig. 7 A) that the surface for cuneiform II is turned almost directly outwards in the chimpanzee; Tabūn I retains this outward direction to a greater degree than does the Bushman (Fig. 7 B, C).

The arrangement of the cuneiform facets on the anterior surface of the os naviculare gives an indication of the development of the transverse arch of the foot; this arch was as well developed in Skhūl IV as in the modern Sikh.

An examination of the navicular has again brought before us one of the many features —often of a simian nature—in which the woman (Tabūn I) differs from the other Palestinians. The differences between Skhūl IV and the Sikh are really less than those between Tabūn I and Skhūl IV. Yet on the points in which Skhūl IV differs from the Sikh he approaches Tabūn I. We regard this feature of Tabūn I as we regard her chin—as an individual or developmental difference, not as an indication of a difference in racial origin.

OS CUBOIDEUM (Pl. III; Fig. 8)

This bone, of which we can find no adequate description in the literature of Neanderthal man, represents one of the most distinctively characterized bones of the Palestinian foot. We have the following three specimens: Tabūn I, right; Skhūl IV, right (imperfect) and left; Skhūl VI, left (imperfect).[1] In Table V (p. 37) these are compared with those of the Bushman, the Sikh, and a chimpanzee.

The Palestinian cuboids are distinguished by their absolute shortness, and particularly by the shortness of the lateral border. In Fig. 8 the Palestinian bones are viewed on their dorsal surface, with sections of their articulations given in sharp outline. The resemblance of Tabūn I (B) and Skhūl IV (C) to the chimpanzee cuboid (A) is at once apparent. As will be seen from Table V (ratio of length of lateral border to medial border), the outer border of Tabūn I is only 41·6 per cent. of the inner border, in Skhūl IV it is 42·8 per cent., in the chimpanzee 45 per cent., while in the modern bones it is 55·5 per cent. in the Bushman and 50 per cent. in the Sikh. Also it is wide in relation to its length. The width of the posterior articular surface is 103·5 per cent. of the length in Skhūl IV, 100 per cent. in Tabūn I, 89 per cent. in the Sikh, and only 74 per cent. in the Bushman.

The area for articulation with the base of metatarsal V is wider and more oblique in the ancient than in the modern bones. The articular surface on the medial aspect of the bone, and that on the calcaneal aspect, differ in no definable way from those on modern bones. The backward projection on the calcaneal surface varies from 4 mm. in Tabūn I to 7·5 mm. in Skhūl IV, the amount for the Bushman being 6 mm. and for the Sikh 7 mm. The groove for the tendon of the peroneus longus is sharply defined by a retro-peroneal ridge which rises 6 mm. above the groove in Tabūn I, 5 mm. in the Bushman, 6 mm. in Skhūl

[1] See note on p. 21.

IV, but only 4·5 mm. in the Sikh, the groove being ill marked in the last named, as is the case in most modern cuboids. On the lateral margin of the cuboid of the chimpanzee there is no articular facet for the flabella in the tendon of the peroneus longus; it is also absent in Tabūn I; it is present in Skhūl IV and is very plain in the two modern bones, used here for comparison.

The compressed wedge shape of the Palestinian cuboid is apparently connected with the fan-like spread of the metatarsal bones (cf. Fig. 1 A, C).

THE CUNEIFORM BONES (Pl. III; Figs. 1, 2, 9)

So far as we can learn only the briefest descriptions have been published of the cuneiform bones of Neanderthal man. We have the following examples from Mount Carmel: Tabūn I, 1, 2, 3, right; 1, 2, 3, left; Skhūl IV, 1, 2, right; 1, 2, 3, left; Skhūl IX, 1, right (imperfect); Skhūl VII, 1, left (imperfect). Side by side with these in Table VI, A, B, C (p. 37) we have included those of the Bushman for comparison with Tabūn I and those of the Sikh for comparison with Skhūl IV. There are considerable differences between the cuneiforms of Tabūn I and the Bushman, whereas a comparison of the Skhūl bones with those of the Sikh brings out resemblances rather than differences.

Data relating to the cuneiform bones will be found in Tables VI A, B, C (p. 37) and in the exact drawings of the foot from above (Fig. 1 A, B, C, D) and from the side (Fig. 2 A, B, C, D). The only one of the cuneiform series which requires a special description is cuneiform I: a diagrammatic section of the proximal and distal articular surfaces is shown in Fig. 9. The chief point of interest relates to the distal joint of cuneiform I for articulation with the first metatarsal. Sections reveal a greater resemblance of Tabūn I and Skhūl IV to the chimpanzee than is the case with the other bones (Fig. 9). The chimpanzee bone differs in the direction of the proximal articulation—it looks backwards and inwards—whereas the human bones look backwards and outwards, particularly in the case of Skhūl IV and the Bushman. The latter angle throws the main axis of the bone into a forward direction, an adaptation to the human gait.

The Tabūn cuneiforms are remarkably short and thick when compared with the Bushman bones. The Skhūl IV bones are also short and thick but in this respect are not remarkably different from those of the Sikh. This relationship is brought out in the Table of Measurements of cuneiform I; the last line gives the ratios of the width to the height of the distal articular surface; the width is 66·6 per cent. of the height in Tabūn I, 60 per cent. in Skhūl IV, and only 52·4 per cent. and 49·5 per cent. in the modern bones.

The articular surfaces on the cuneiform bones, lateral and medial, as well as distal and proximal, differ in no essential way from the modern bones which we used for purposes of comparison.

THE METATARSALS AND PHALANGES (Pl. II; Figs. 10, 11, 12, 13, 14)

First Metatarsal.

There are four first metatarsals of the right foot, viz.: Tabūn I, Skhūl IV (proximal two-thirds), Skhūl V, Skhūl IX (proximal fragment). There are four belonging to the left foot, viz.: Tabūn I, Skhūl IV, Skhūl IX (distal fragment), Skhūl 3.

Measurements are given in Tables VII, VIII, IX, X (pp. 38–9).

An examination of the first metatarsal is important because of the light thrown on posture and manner of progression. As the articular surfaces and shape of the shaft do not differ markedly from those of modern man we infer that the Palestinians used their hallux in the same manner as we do. The measurements of the complete bones are given in Table VII.

The first metatarsals of Tabūn I differ in size and shape from the others; we shall deal with them first. In Fig. 10 the dorsal surface of the left bone is compared with that of a Bushman. The Tabūn specimen is the shorter; it is also wide and squat. A section at the mid-point of the shaft is represented in Fig. 10 A′; the outline is seen to be roughly triangular whereas in the Bushman the section is almost circular.

If, however, the corresponding sections from Skhūl IV and a Sikh are compared (Fig. 10 C′, D′) it will be seen that the Skhūl shaft is nearly circular while that of the Sikh is triangular. Although the stature of the Sikh was 1,666 mm., his metatarsal is smaller in nearly all dimensions; the first metatarsal of Skhūl IV is really a massive bone. The fragments of Skhūl IX indicate that the first metatarsal of this male was equally large. In the gorilla (Fig. 11 E) the corresponding section is also triangular, but owing to the torsion of the shaft the dorsal surface is directed towards the medial plane.

In Fig. 11 are depicted the proximal surfaces for articulation with the ento-cuneiforms, and it may be said at once that these surfaces indicate that the manner of articulation is similar to that in modern man. In Fig. 11 A is represented the proximal surface of the first (left) metatarsal of a chimpanzee; it is kidney-shaped, the indentation being on the lateral side of the articular outline. The transverse axis of the head of the metatarsal is indicated by the oblique line. The surface is shaped so as to receive the semi-cylindrical surface of the ento-cuneiform. Below the indentation is a projection, seen best in a dorsal view (Figs. 1, 2). The proximal articular surface in the Bushman is also kidney-shaped (Fig. 11 C), but there has appeared an indentation on the opposite or convex margin, so that the renal area is divided into upper and lower halves. The articular surface is less concave than in the chimpanzee, but the outline and direction is not materially different. In the Sikh (Fig. 11 G) the articular surface is more extensive but the renal shape is retained, with the medial and lateral indentations.

When we turn to the corresponding articulation in Tabūn I (Fig. 11 B) the surface is seen to have a kidney shape, but is short, flat, and broad; there is a lateral indentation but no medial. In Skhūl IV (Fig. 11 D) the kidney shape with the lateral indentation is recognizable; the area is wide and flat. This is also the case with Skhūl 3 (Fig. 11 F), although in this instance the articular surface was evidently narrower. In Skhūl IX the articular surface was apparently kidney-shaped. As will be seen from an inspection of Figs. 10 and 11, the medial and lateral margins of the proximal articular surface of the first metatarsal project backwards to an equal extent and the depth of the cavity between these margins in all cases, both ancient and modern, is about 2 mm. Nor have we succeeded in discovering characters which distinguish the distal articular head of the first metatarsal of the ancients from that of the moderns. On the under-surface of the distal articular end are the two trochlear surfaces for the sesamoids, separated by a median ridge.

On the lateral aspect of the proximal end of Skhūl IV and Skhūl 3 there is an oval, flat, articular surface, indicating an articulation of the proximal end of metatarsal II with the base of metatarsal I.

In Fig. 12 A is shown a lateral view of the first metatarsal of Tabūn I (right and left), of Skhūl 3, and of a Bushman. This view is particularly important because it reveals the extent to which the plantar basal bar has been developed in the first metatarsal. In the lower primates the shaft of the first metatarsal is shaped much as that of the thumb, with a dorsal and plantar surface. With the formation of the plantar basal bar the plantar surface becomes divided into lateral and lower surfaces. With the evolution of human posture the plantar bar attains great strength. In Tabūn I this bar is developed to about the same degree as in the Bushman, while in Skhūl IV and Skhūl 3 it is as strongly developed as in the Sikh.

We have also noted the relationship of the vertical axis of the proximal end to the transverse axis of the distal end. The lateral margin of the proximal end was taken as representative of the vertical axis, and the transverse axis of the distal end was drawn so as to divide the head into upper and lower moieties. As a rule, in modern feet the proximal and distal axes are approximately at right angles to each other. In the chimpanzee the head is twisted (cf. Fig. 11 A) so that its dorsal aspect looks inwards as well as upwards, its axis forming not a right angle but one of 55° with the vertical. In Skhūl IV this angle is 76°; in the Bushman 81°; in Tabūn I 75°; in the Sikh 85°. There is thus a lesser degree of torsion in the fossil Palestinians than in the modern bones used for comparison. In La Chapelle man this angle is 65°. The only complete metatarsal bone we have found recorded in the literature on Neanderthal man is one found at Krapina. The Krapina bone is very similar in size and character to those from Mount Carmel.

Metatarsals II, III, IV, V.

We have the following examples of the remaining metatarsals:

Tabūn I, right foot, II, III, IV, V; left foot, distal end of II or III.

Skhūl IV, right foot, II, III, IV, V (imperfect).

Skhūl IV, left foot, II, III, IV, V.

Skhūl IX, right foot, imperfect proximal end of II.

For comparison with the Tabūn I series we have used the corresponding metatarsal series of the Bushman; with the Skhūl series the metatarsals of the right foot of the Sikh.

The measurements are given in Table VIII (p. 38).

In the measurements of the fifth metatarsal (Table VIII) the tuberosity is included in the length. If the length is taken along the medial border, from the median margin of the basal articulation, and this deducted from the measurements given, the length of the tuberosity is obtained. The length of the tuberosity in Tabūn I is 9 mm., in the Bushman 7 mm., in Skhūl IV (left) 15 mm., in the Sikh 11 mm. In calculation of the percentage length of the metatarsals the length of the tuberosity is excluded for that of the fifth metatarsal.

The measurements given in Table VIII are the same as those taken on the first metatarsal, save in the case of the diameters at the mid-point of the shaft. Those given express the greatest and least diameters at this point. The length of metatarsal III is taken as the standard in Table IX (p. 38) and the lengths of the other metatarsals are expressed as percentages of the length of metatarsal III.

The first point to emerge from these tables of measurements is the relative shortness of metatarsal I of Tabūn I. This is only 70·8 per cent. of the length of the standard,

metatarsal III, whereas in the Bushman the hallucial metatarsal is 92·2 per cent.—an uncommon proportion in a human foot. On the other hand, the difference between Skhūl IV and the Sikh is not great—80·6 per cent. in Skhūl and 81·5 per cent. for the Sikh. A short hallucial metatarsal is an anthropoid character.

Although metatarsal II is absolutely longer than the standard, metatarsal III, this difference disappears in the articulated foot, owing to the base of metatarsal II being wedged between the first and third cuneiforms. The amount of inter-callation is practically the same in the fossil as in the modern foot.

Metatarsal IV is relatively short in Tabūn I (91·9 per cent.) whereas in Skhūl IV and in the Sikh the proportions are almost the same. On the other hand, metatarsal V is relatively longer in the fossil feet.

If the tables of measurements (Tables VIII, IX, p. 38) are examined the following differences may be noted: the measurements of the proximal ends are somewhat greater in Tabūn I than in the Bushman; the measurements of the distal ends are almost the same but, as regards the shafts, those of the Bushman are greater for metatarsals II and III, while in Tabūn I those for metatarsals IV and V are the greater.

When the measurements for Skhūl IV and the Sikh are compared there is seen to be a high degree of similarity in all save those for the proximal ends of the Sikh's metatarsals, which are wider, while the shafts of the Skhūl bones are greater in both diameters. As regards the distal ends, there is a close agreement both in size and shape. Indeed, the most marked difference between the shafts of the fossil and the modern metatarsals lies in the pronounced ridging of the shafts of Skhūl IV; along the dorsal aspect of the shafts run high, sharp ridges, separating the origins of the dorsal interosseous muscles. This ridge is almost median in position in metatarsal II, whereas in metatarsals III and IV the surface lateral to the ridge becomes more extensive and lies vertical in position. In the Sikh the median ridge is still towards the lateral side of the shaft, but in Tabūn I and in the Bushman, although the ridges are only slightly indicated, the arrangement is as in Skhūl IV, in which the first and second dorsal interosseous muscles were inserted on the second digit.

When we compare the articulations on the bases of the metatarsal bones we find fossil and modern bones in complete agreement. On the base of metatarsal II we find the tarsal surface triangular and slightly concave; on the medial margin is a small surface for the first cuneiform; on its lateral aspect an upper (double) and a lower articular surface, separated by a deep furrow. The surfaces are for articulation with the third cuneiform and the base of metatarsal III. One remarkable feature is seen on the lateral aspect of the base, in front of the above-mentioned furrow; it is a rough, raised area, evidently for ligamentous attachment. This is present in all the metatarsals both of Skhūl IV and of Tabūn I.

The articular surface at the base of III is also triangular, slightly convex, and oblique in direction. On the medial margin is a facet for metatarsal II and on its lateral for metatarsal IV. On the base of metatarsal III of Tabūn I the surface is slightly concave from side to side. In metatarsal IV the base is four-sided, somewhat saddle-shaped, with the usual extensive articular areas for contact with metatarsals III and V; there is also an impression for the third cuneiform. The base of metatarsal IV of Tabūn I shows the same areas.

The base of metatarsal V is remarkable for its relative massiveness both in Tabūn I and Skhūl IV. The articular surface for the cuboid is triangular in shape with the apex at the base of the tuberosity. The direction of this surface is more oblique—directed more laterally—than in modern bones. On the medial surface is an extensive area for articulation with metatarsal IV.

The chief points to be noted in the conformations of the metatarsals are: (1) the greater development of the interosseous muscles, especially in Skhūl IV; (2) the articulation of the bases of the metatarsals is as in modern bones; (3) the transverse arch was similar in its convexity to that seen in the feet of modern native people.

In dealing with the tarsal bones, the axes which these make with the metatarsals have been touched upon. We may add that the position of metatarsal I to the other metatarsals was in Skhūl IV as it is in the Sikh and as in the feet of modern natives, but in Tabūn I the space between the first metatarsal and metatarsal II was certainly divergent to a greater degree than in the Bushman.

THE PHALANGES OF THE TOES

We have the following specimens of the phalanges:

Tabūn I. *Right foot.*

I. Base of proximal phalanx.
II. Proximal, middle, and distal (imperfect).
III. Proximal.
IV. Proximal.

Skhūl IV. *Right foot.*

I. Proximal, distal.
II. Proximal, middle.
III. Proximal (fragment), middle (fragment).
IV. None.
V. None.

Left foot.

I. Proximal, distal.
II. Proximal, middle, and distal.
III. Proximal, middle, and distal.
IV. Proximal, middle.
V. Proximal.

Skhūl IX. Two middle phalanges, possibly right IV, V.

We have given the measurements of the phalanges and metatarsal bones in some detail because they provide us for the first time with a basis for estimating the relative and absolute development of digits in the feet of ancient man. The main issues which emerge are those of resemblances to, rather than differences from, the foot and toes of modern man. (Table X A, B, p. 39.)

In Fig. 13 a comparison is made of the phalanges of the great toe of the right foot of Skhūl IV and the Sikh; we have already noted the many points of agreement in the tarsal bones of these individuals; it is so here. The pulp-carrying tip of the distal

phalanx of Skhūl IV is peculiar, but otherwise the differences are of a minor nature. The Palestinian bones tend to be more cylindrical and longer than those of the Sikh. This is the case as regards the great toe, but it is not so in the case of the proximal phalanges of the other toes. The phalanges continue the line of the metatarsal bone in the case of Skhūl IV (Fig. 2 c).

Of Tabūn I we have only the basal end of the proximal phalanx of the great toe. The fragment resembles the corresponding part of the Bushman, save that it is rounder in the ancient woman than in the Bushman.

There are two evolutionary changes in the human foot that are of immediate interest. The first change is that which gives the second digit of the foot the chief and strongest position in the human digital series. In the gorilla and the chimpanzee it is the third which occupies this position. All stages in the transference from III to II can be demonstrated in the feet of primitive races. In all four feet used in our series, Tabūn I, Skhūl IV, Bushman, and Sikh, the second digit is the longer—but in varying degrees—which will be apparent from a study of the measurements relating to the metatarsal bones. The base of metatarsal III may exceed that of II, but in all the specimens the distal end or head of metatarsal II will be seen greatly to exceed that of metatarsal III.

When we come, however, to consider the extent to which regression has overtaken the more laterally situated toes in the evolution of man, we find fossil man at an earlier and more primitive stage, one in which the third digit is in a more robust state than in modern man. This is made apparent by the drawing shown in Fig. 14. In modern feet the middle phalanx of III has assumed the shaftless form; it has become reduced to its two articular extremities. In Skhūl IV this is not so, for the middle phalanx is still robust; whether this was so in Tabūn I is doubtful. We have one middle phalanx, probably of digit II, and this has a long shaft.

An examination of the measurements relating to all the elements of digits II, III, IV will show that these have undergone a less degree of reduction in the ancient than in the modern feet. The reduction affects first and most the middle phalanx, secondly the proximal phalanx. The extent of these reductions will be learned from our tables of measurements (Table X a, p. 39).

Table I. THE FOOT

	Tabūn I	*Bushman*	*Skhūl IV*	*Sikh*
	R	R	L	L
Length of tarsus*	101·0	103·0	119·0	115·0
Index: tarsus—total foot length	45·5	48·0	46·0	48·0
Length of metatarsus (Met. II)	70·0	65·0	78·0	65·0
Index: metatarsus—total foot length	31·5	30·0	30·4	27·2
Length digital element (phalanges of digit II)	51·0	42·0	59·0	51·0
Index: digit—total foot length	23·0	22·0	23·2	24·8
Total length of foot†	222·0	215·0	256·0	239·0
Breadth of foot‡	60·0	54·0	61·0	66·0
Index: length–breadth of foot	27·0	25·1	23·8	27·6
Tarso-metat. I length§	155·0	167·0	188·0	180·0
Tarso-metat. II length	171·0	168·0	197·0	180·0
Index: tarso-metat. I to tarso-metat. II length	90·6	99·4	95·4	100·0
Tarso-metat. III length	166·0	162·0	189·0	181·0
Index: tarso-metat. III to tarso-metat. II length	97·0	96·4	95·9	100·5
Tarso-metat. IV length	152·0	156·0	184·0	176·0
Index: tarso-metat. IV to tarso-metat. II length	88·8	92·8	93·4	97·7
Tarso-metat. V length	144·0	143·5	174·0	166·0
Index: tarso-metat. V to tarso-metat. II length	84·2	85·8	88·3	92·2
Tarso-phalanx I length‖	..	216·0	247·0	237·0
Tarso-phalanx II length	222·0	215·0	256·0	239·0
Index: tarso-phalanx I to tarso-phalanx II length	..	100·4	96·5	99·1
Tarso-phalanx III length	..	204·0	243·0	236·0
Index: tarso-phalanx III to tarso-phalanx II length	..	94·8	95·0	98·7

* Description of this measurement in text, p. 19.

† Description of this measurement in text, p. 19.

‡ Description of this measurement in text, p. 19.

§ Distance from mid-point on the posterior margin of the tuber calcanei to the mid-point on the distal margin of the head of the metatarsal bones. The standard for determining the proportions of the tarso-metatarsal lengths is that from the tuber calcanei to the head of metatarsal II.

‖ Distance from the mid-point on the posterior margin of the tuber calcanei to the tip of the distal phalanx. The standard for determining the proportions of the tarso-phalangeal lengths is that from the tuber calcanei to the tip of the distal phalanx of digit II.

Table II. THE TALUS

	Tabūn I		*Bush-man*	*Skhūl IV*		*Sikh*	*Skhūl* V	*Skhūl* VI	*Skhūl* VII	*Krapina*
	R	L	R	R	L	L	L	L	R	
Length M 1*	46·2	46·0	48·0	54·0	55·5	53·0	51·0	58·0	(48·0)	53·3
Width M 2	37·0	36·0	38·0	46·0	(47·0)	43·0	(43·0)	45·0	(37·0)	42·5
Height M 3	28·0	28·0	27·0	32·0	32·0	32·0	34·0	33·0	..	29·5
Trochlea:										
length M 4	29·5	31·0	30·5	34·0	35·0	35·0	39·0	37·0	32·0	30·0
post. width M 5 (1)	25·0	25·0	24·0	25·0	27·0	27·2	29·0	30·0	24·0	25·0
ant. width M 5 (2)	28·0	28·0	26·0	32·0	31·0	32·0	35·0	34·0	31·0	29·2
Length–width index	80·8	78·2	79·1	85·1	84·6	81·1	84·3	77·5	..	79·7
Length–height index	60·6	60·8	56·2	59·2	57·6	60·3	66·6	56·8	..	55·3
Proj. of lat. mall. surf. M 7*a*	8·0	8·0	10·0	11·0	12·0	10·0	9·0+	13·5	..	..
Proj. of medial mall. artic.	3·0	3·5	3·5	5·0	7·0	8·0	..	5·0	..	..
Length of head and neck M 8	15·0	16·0	19·0	18·5	20·0	20·0	13·0	20·0	..	..
Head:										
length M 9	28·0	28·0	30·0	35·0	37·0	34·0	(37·0)	34·0	..	29·4
breadth M 10	20·0	22·0	21·0	26·0	26·0	25·0	(24·0)	25·0	..	20·6
Post. calc. artic.:										
length M 12	26·5	27·0	28·0	36·5	(38·0)	35·0	(35·0)	31·0	..	..
width M 13	19·0	20·0	20·0	23·0	23·0	22·0	23·0	22·0	..	..
depth M 14	4·8	5·0	4·8	7·4	(6·0)	5·8	(5·0)	4·0	..	..
Head and neck—total length Ind.	32·4	34·7	39·5	34·2	36·0	37·7	25·5	34·4	..	..
Angle of neck to body M 16	21·0°	18·0°	35·0°	26·0°	28·0°	32·0°	27·0°	24·0°	..	..
Angle of head with horiz. plane M 17*a*	29·0°	32·0°	23·0°	38·0°	40·0°	30·0°	37·0°	..	..	..

* M 1, M 2, &c., refer to Martin's measurements (*Lehrbuch der Anthropologie*, vol. 2, 2nd ed., 1928).

Table III A. THE CALCANEUS

	Tabūn I		*Bushman*	*Skhūl IV*		*Sikh*	*La Chapelle*	*La Ferrassie*
	R	L	R	R	L	L		
Total length M 1	70·0	(71·0)	73·0	83·0	81·0	76·0	80·0	85·0
Max. width M 2	39·0	..	40·0	44·0	45·0	44·0	47·0	..
Width–length Index	55·7	..	56·3	53·0	55·5	57·9	58·0	..
Min. width M 3	27·0	..	24·0	30·0	28·0	31·0	30·0	..
Height M 4	37·0	(36·0)	34·0	45·0	46·0	43·0	42·0	..
Height–length Index	52·8	50·7	46·5	54·2	56·8	56·5	52·5	..
Heel (tuber calc.):								
height M 7	40·0	..	40·0	48·0	52·0	49·0	..	..
width M 8	29·0	..	27·0	33·0	34·0	31·0	..	..
length*	28·0	..	33·0	35·0	33·0	30·0	..	..
Length of heel—total length Ind.	40·0	..	45·8	42·6	40·7	40·0	..	..

* Length of heel: that proportion of the total length which falls behind the hinder border of the posterior articular facet.

Table III b. THE CALCANEUS

	Tabūn I		*Bush-man*	*Skhūl IV*		*Sikh*	*La Chapelle*	*Skhūl VI*	*Krapina*	*Gorilla*
	R	L	R	R	L	L		L		R
Sustentaculum:										
width	12·0	14·0	16·0	15·0	13·0	11·0	16·0	(15·0)	..	16·0
thickness	9·0	9·5	9·5	12·5	13·5	9·0	..	(11·0)	10·0	14·0
Ant. calc. artic.:										
length	35·0	31·0	31·0	34·0	38·0	34·0	35·0	35·0	31·0	33·0
width	11·0	11·0	12·0	11·0	12·0	13·0	..	14·0	8·5	20·0
Post. artic.:										
length M 9	26·0	27·0	25·0	33·0	32·0	32·0	..	..	..	29·0
width M 10	22·5	24·0	21·0	(27·0)	25·0	24·0	..	..	..	23·0
convexity M 11	5·5	3·5	6·0	4·0	5·0	7·0	..	..	..	9·0
angle M 14	33·0°	(40·0°)	48·0°	55·0°	48·0°	60·0°	..	..	..	15·0°
Cuboid artic.:										
height M 12	23·0	23·5	21·0	31·0	29·0	28·0	..	..	28·0	27·0
width M 13	19·5	20·0	24·0	(24·0)	25·0	25·0	..	..	15·0	14·5

Table IV. OS NAVICULARE

	Tabūn I		*Bushman*	*Skhūl IV*		*Sikh*
	R	L	R	R	L	R
Width M 1	38·5	..	35·0	39·0	39·5	40·5
Height M 2	(25·0)	24·0	22·0	28·0	27·0	29·0
Post. facet:						
length M 3	26·2	25·0	27·0	28·0	28·0	29·0
width M 4	(18·0)	18·0	17·2	24·0	23·0	26·0
depth M 5	6·0	6·0	4·8	6·0	5·6	5·5
Width artic. surface for cuneiforms M 6	32·0	..	32·0	37·0	37·0	36·0
Thickness:						
facet for cuneiform III M 7	7·5	7·0	8·0	8·5	7·5	8·5
facet for cuneiform I M 8	21·2	..	13·2	17·5	18·3	19·3
Tuberosity:						
ant.-post. diam.	19·0	..	12·0	17·0	18·0	18·0
thickness (dorso-ven. diam.)	13·0	..	9·0	13·5	14·0	13·0

Table V. OS CUBOIDEUM

	Tabūn I	*Bushman*	*Skhūl IV*		*Sikh*	*Chimpanzee*
	R	R	R	L	L	
Length:						
upper medial aspect M 1	24·0	27·0	..	28·0	32·0	20·0
middle medial aspect M 1	22·0	24·0	26·0	27·0	30·0	19·0
lower medial aspect M 1*	28·0	33·0	34·5	34·5	37·0	20·0
lateral border M 2	10·0	15·0	..	12·0	16·0	9·0
Post. artic. surface:†						
height	22·0	21·0	..	23·0	22·0	14·5
width	24·0	20·0	..	29·0	28·5	20·0
Ant. artic. surface:						
height	16·0	14·2	16·6	18·0	17·0	12·0
width	23·0	19·5	27·0	26·0	28·0	22·0
Depth of groove, peroneal tendon‡	6·0	5·0	5·0	6·0	4·5	5·0
Ratio: length of lateral border to upper medial border	41·6	55·5	..	42·8	50·0	45·0

* The difference between the middle and lower lengths of the medial border of the cuboid gives the backward projection of the cone which passes under the calcaneus. † Measured at right angles to the lower border.
‡ The projected height of the retroperoneal ridge when the plantar surface is held horizontally.

Tables VI A, B, C. CUNEIFORMS I, II, III

A. CUNEIFORM I

	Tabūn I	*Bushman*	*Skhūl IV*		*Skhūl IX*	*Sikh*	*Skhūl VII*
	R	R	R	L	R	L	L
Lower length M 1	22·0	23·0	23·0	23·0	27·5	26·0	23·5
Upper length M 3	21·0	19·0	22·0	21·0	25·3	23·0	..
Prox. artic. height M 4	19·0	22·0	22·5	23·0	..	23·0	..
Prox. artic. width	14·5	13·0	14·0	14·4	..	16·0	(15·0)
Distal artic. height M 5	24·0	27·5	29·5	30·0	(29·0)	30·5	..
Distal artic. width*	16·0	13·5	18·0	18·0	(17·0)	16·0	..
Width–height index of distal artic.	66·6	49·5	61·0	60·0	58·6	52·4	..

* Measured at right angles to the two most outstanding points of the lateral border.

B. CUNEIFORM II

	Tabūn I		*Bushman*	*Skhūl IV*		*Sikh*
	R	L	R	R	L	L
Upper length M 1	15·3	15·0	13·5	15·6	15·5	17·3
Prox. artic. height	(18·0)	(18·0)	17·0	..	22·2	22·1
Max. prox. width M 4	13·0	13·6	12·0	(12·0)	15·5	17·0
Distal artic. height	(15·0)	..	18·0	21·6	23·0	22·0
Distal width M 3	13·0	13·0	11·0	13·0	12·0	15·5
Width–height index of distal artic.	86·6	..	61·1	60·0	52·1	70·4

C. CUNEIFORM III

	R	L	R	R	L	L
Upper length M 1	20·0	21·0	20·0	..	19·5	25·0
Prox. artic. height	11·0	11·6	15·0	..	15·5	17·0
Max. prox. width M 4	11·0	12·0	12·0	..	11·2	12·5
Distal artic. height	21·0	..	19·5	..	21·5	23·0
Distal width M 3	(13·0)	14·5	14·0	..	17·0	17·0
Width–height index of distal artic.	63·6	..	71·8	..	80·0	73·9
Ratio: upper medial to upper lateral border	84·0	78·5	77·2	..	81·8	84·0

Table VII. FIRST METATARSAL

	Tabūn I		*Skhūl 3*	*Skhūl IV*		*Skhūl V*	*Skhūl IX*		*Sikh*	*Bushman*	*Krapina*
	R	L	L	R	L	R	R	L	L	L	
Total length M 1	51·0	52·5	58·0	..	64·5	50·0	..	..	61·5	59·0	58·0
Prox. end:											
dor.-ven. diam. M 7	22·0	(22·0)	30·5	29·0	29·0	..	..	..	30·0	25·5	31·6
trans. diam. M 6	18·5	17·5	22·0	24·0	23·0	(23·0)	21·0	..	22·0	17·0	..
Mid-point of shaft:											
dor.-ven. diam. M 4	(9·0)	9·5	13·5	14·5	15·0	16·2	..	..	14·2	12·0	13·2
trans. diam. M 3	13·4	13·0	14·5	17·0	17·2	15·0	..	..	15·2	11·0	16·0
Distal end:											
dor.-ven. diam. M 9	17·2	18·0	20·7	..	21·0	19·0	..	(21·0)	21·0	17·0	21·5
trans. diam. M 8	20·0	20·0	22·5	..	23·0	21·0	..	..	24·0	18·0	23·1

Table VIII. METATARSALS II, III, IV, V

	Tabūn I					*Bushman*			
	R				L	R			
	II	III	IV	V	II	II	III	IV	V
Total length	(74·0)	72·0	(66·0)	(69·0)	..	70·0	64·0	62·0	60·0
Prox. end:									
dor.-ven. diam.	19·0	19·0	(17·0)	14·5	..	17·0	17·0	15·0	12·0
trans. diam.	13·5	13·0	12·0	21·0	..	12·5	12·4	11·0	18·5
Mid-pt. of shaft:									
dor.-ven. diam.	7·0	8·0	9·0	11·0	..	7·7	8·5	8·5	9·5
trans. diam.	6·5	6·0	6·0	6·0	..	7·0	6·5	5·2	6·8
Distal end:									
dor.-ven. diam.	15·0	14·0	(12·0)	..	13·0	14·0	13·0	12·0	10·5
trans. diam.*	9·8	(8·3)	(8·0)	..	9·5	8·8	8·0	8·0	9·0

	Skhūl IV								*Skhūl IX*	*Sikh*			
	R				L				R	R			
	II	III	IV	V	II	III	IV	V	II	II	III	IV	V
Total length	83·0	80·5	78·0	..	82·0	80·0	77·0	83·0	..	77·0	76·0	73·0	73·0
Prox. end:													
dor.-ven. diam.	24·0	21·0	19·5	..	24·0	(21·0)	20·0	16·0	21·0	23·0	21·0	14·0	17·0
trans. diam.	15·0	15·0	14·0	..	14·2	15·0	12·0	23·0	13·0	18·4	16·0	13·2	22·0
Mid-pt. of shaft:													
dor.-ven. diam.	11·5	11·0	11·0	12·0	14·0	13·0	11·0	11·5	..	9·5	9·5	9·0	11·0
trans. diam.	8·2	7·5	8·0	9·5	8·5	(10·0)	8·0	9·0	..	7·5	8·0	7·0	9·0
Distal end:													
dor.-ven. diam.	16·5	16·0	15·0	(14·0)	17·0	16·0	15·0	14·0	..	17·0	16·0	15·5	14·0
trans. diam.*	12·2	12·0	12·0	..	13·0	11·0	10·4	11·0	..	13·0	10·5	11·0	10·5

* Excluding the lateral tuberosities.

Table IX. METATARSAL INDICES

	Tabūn I	*Bushman*	*Skhūl IV*		*Sikh*
	R	R	R	L	R
Metatar. I	70·8	92·2	..	80·6	81·5
Metatar. II	102·7	109·3	103·1	102·5	101·3
Metatar. III	100·0	100·0	100·0	100·0	100·0
Metatar. IV	91·9	96·8	96·8	96·2	96·0
Metatar. V	83·3	82·8	..	85·0	81·5

Table X A. PHALANGES OF TOES, DIGITS II, III, IV, V

	Tabūn I			*Bushman*				*Skhūl IV*					*Sikh*			*Skhūl IX*
	R			R				R	L	R	L	L	L			
Proximal phalanx	II	III	IV	II	III	IV	V	II	II	III	III	IV	II	III	IV	IV
Maximum length M 1	22·5	20·0	(16·0)	26·0	24·5	23·0	21·0	30·2	32·0	..	30·0	28·0	32·0	27·5	26·0	..
Dor.-ven. diam. of prox. end	11·2	10·5	10·5	10·5	9·5	8·6	8·5	13·0	13·0	12·0	12·0	11·5	14·0	12·2	12·0	..
Trans. diam. of prox. end	12·0	12·0	..	11·5	10·0	10·0	10·0	14·0	15·0	12·8	13·2	13·0	14·4	12·0	12·0	..
Dor.-ven. diam. at mid-pt. of shaft M 3	6·0	6·0	5·0	6·0	5·0	4·5	3·8	8·2	8·0	..	7·0	6·2	8·5	7·0	7·0	..
Trans. diam. at mid-pt. of shaft M 2	6·5	7·0	6·0	5·0	4·0	3·2	4·0	..	7·5	..	8·0	7·0	7·2	6·5	7·0	..
Dor.-ven. diam. of distal end	6·0	7·0	..	5·0	4·5	4·2	5·0	7·2	7·0	..	7·0	6·0	7·0	6·2	6·0	..
Trans. diam. of distal end	9·0	10·0	(10·0)	8·0	7·0	7·0	8·0	10·1	11·0	..	10·0	9·0	11·0	10·0	10·0	..
Middle Phalanx																
Maximum length M 1	10·3	..	..	12·5	9·0	..	..	(18·5)	17·0	..	16·0	14·2	13·0	9·0	8·0	(13·5)
Dor.-ven. diam. of prox. end	8·4	..	..	7·0	6·0	..	..	12·5	9·6	..	9·5	9·0	9·6	9·0	9·0	8·1
Trans. diam. of prox. end	9·7	..	..	8·2	7·6	..	..	11·5	12·0	..	11·0	10·0	11·5	11·0	11·0	9·2
Dor.-ven. diam. at mid-pt. of shaft M 3	4·0	..	..	3·0	2·5	..	..	7·2	6·0	..	6·0	6·0	6·0	5·0	5·0	4·5
Trans. diam. at mid-pt. of shaft M 2	6·5	..	..	5·0	6·0	..	..	8·6	8·0	..	8·0	7·0	9·0	9·2	9·0	5·7
Dor.-ven. diam. of distal end	4·5	..	..	4·0	3·0	..	..	..	6·0	..	6·5	5·5	6·5	6·0	6·0	5·0
Trans. diam. of distal end	9·4	..	..	10·0	7·0	..	..	..	9·8	..	9·3	9·0	10·0	9·0	9·0	(8·0)
Distal Phalanx																
Maximum length M 1	11·0	..	..	10·0	..	..	..	(11·0)	..	10·5	..	..	10·0	..	..	..
Dor.-ven. diam. of prox. end	7·0	..	..	5·0	..	..	..	6·0	..	7·0	..	..	7·0	..	..	..
Trans. diam. of prox. end	(9·5)	..	..	7·2	..	..	..	13·0	..	10·0	..	..	11·0	..	..	..

Table X B. PHALANGES OF THE GREAT TOE

	Tabūn I	*Bushman*	*Skhūl IV*		*Sikh*
Proximal phalanx	R	R	R	L	R
Maximum length	..	..	35·0	34·0	34·0
Prox. end:					
dor.-ven. diam.	14·0	14·0	17·0	16·7	16·0
trans. diam.	16·0	17·0	20·8	20·6	21·0
Mid-pt. of shaft:					
dor.-ven. diam.	..	..	11·0	11·0	10·0
trans. diam.	..	..	13·0	13·5	15·0
Distal end:					
dor.-ven. diam.	..	..	11·6	11·0	11·5
trans. diam.	..	..	17·0	16·6	19·0
Distal phalanx					
Maximum length	..	..	24·0	..	27·0
Prox. end:					
dor.-ven. diam.	..	..	11·7	10·4	12·0
width	..	..	21·0	20·9	21·5



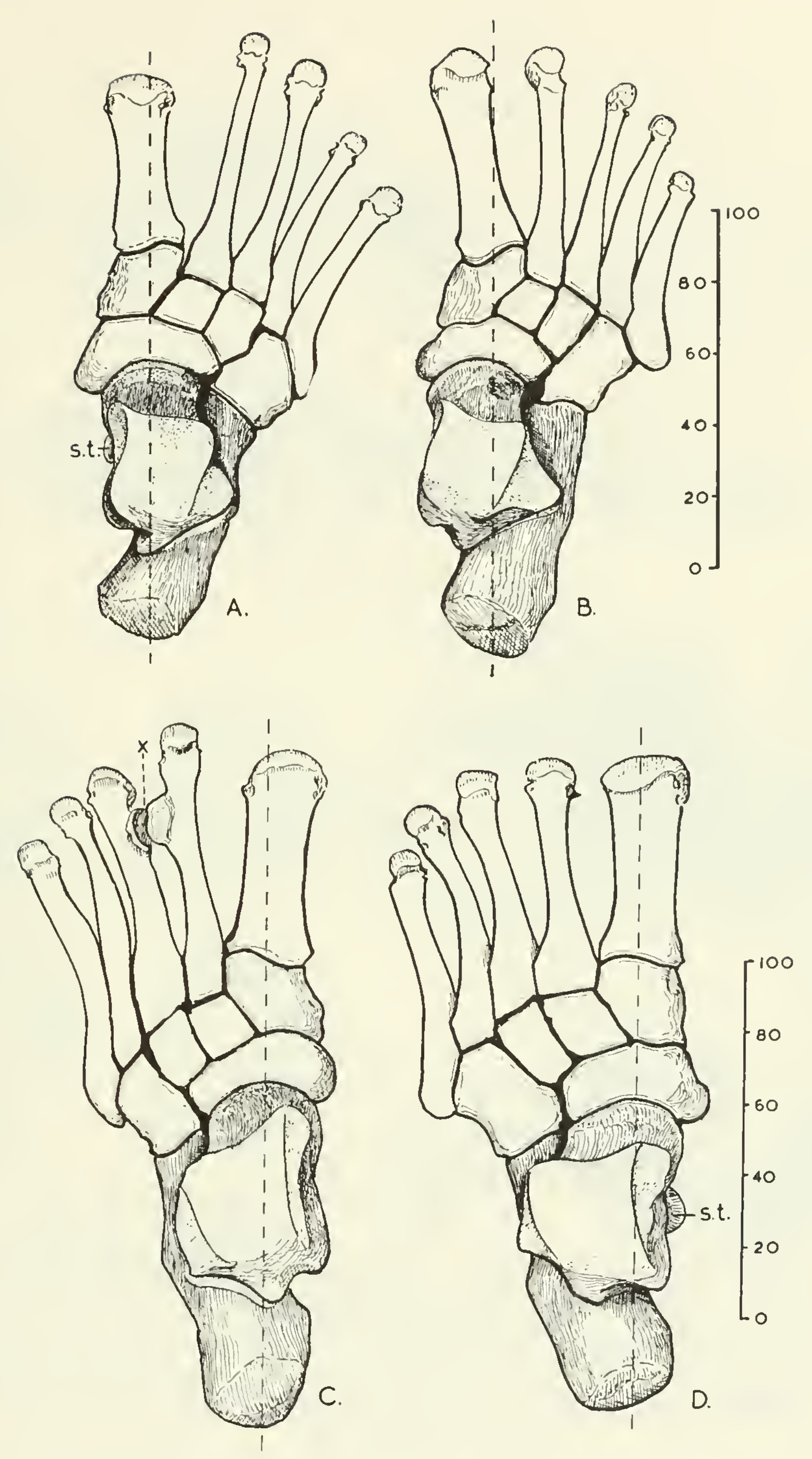


Fig. 1. Dorsal Aspect of the Foot (Tarsus and Metatarsals). A, Tabūn I; B, Bushman (male); C, Skhūl IV; D, Sikh (male). The bones were articulated and held together on a plane surface with plasticine. The drawings are made at right angles to the plane on which the sole of the foot rested. The axis of the foot is indicated by a broken line. *s.t.*, sustentaculum tali; *x*, osseous growth. Scale in millimetres.

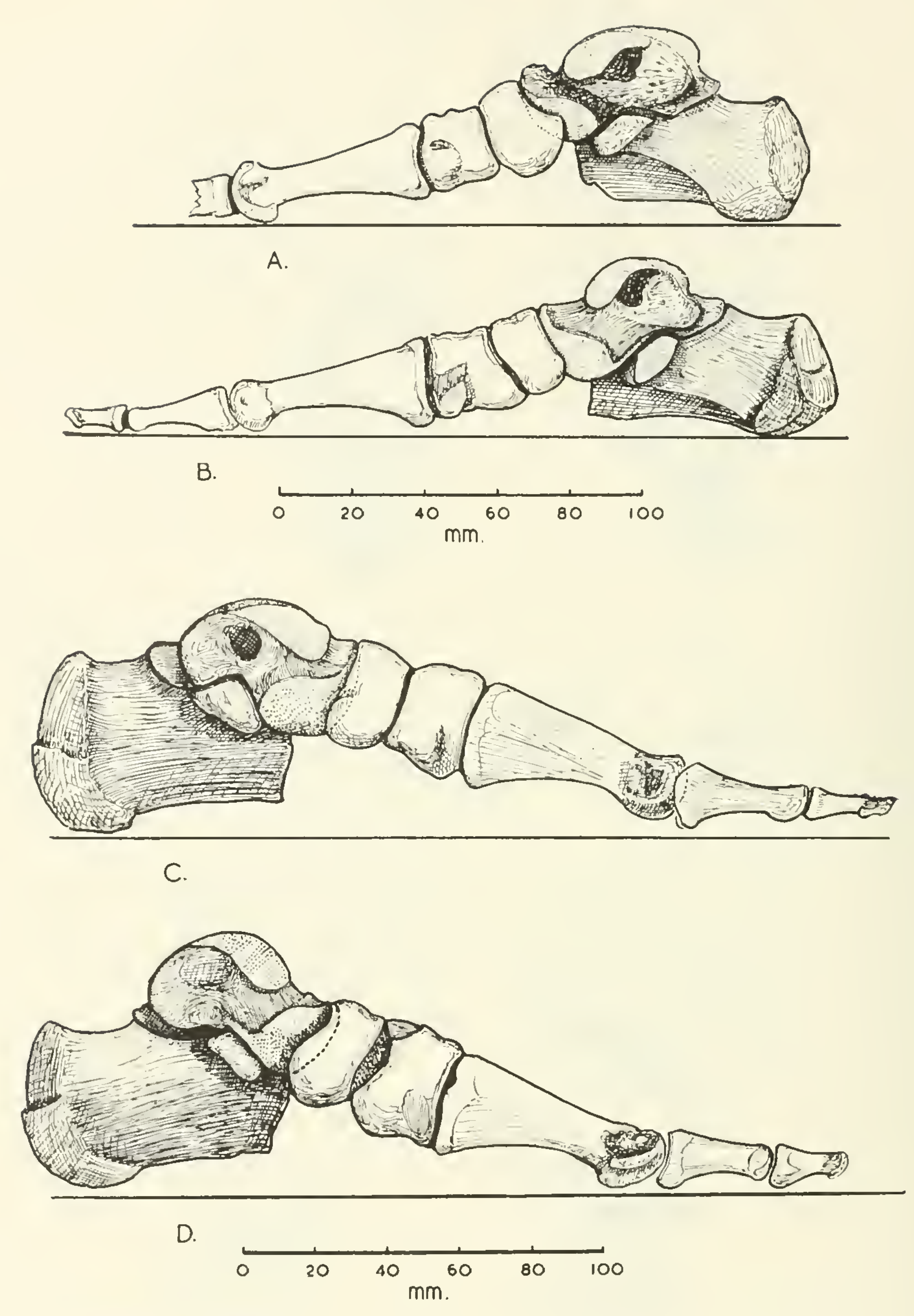


FIG. 2. MEDIAL ASPECT OF THE FOOT. A, Tabūn I, right; B, Bushman, right; C, Skhūl IV, left; D, Sikh, left. The foot is orientated as in Fig. 1.

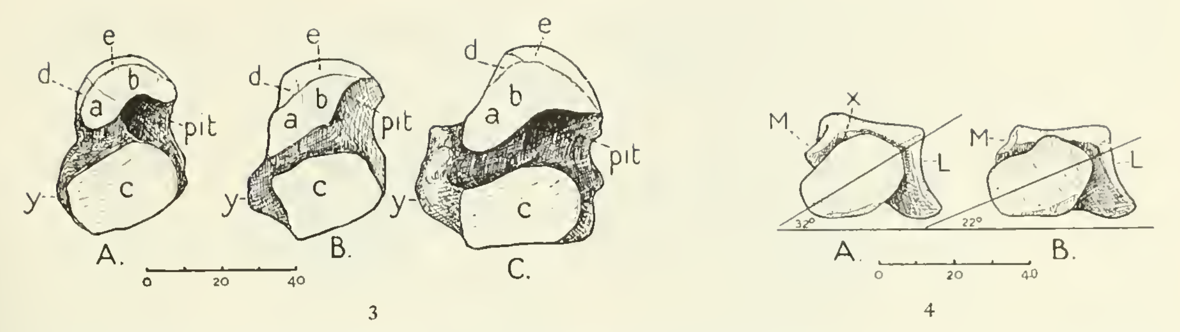


FIG. 3. THE LEFT TALUS, PLANTAR ASPECT. A, Tabūn I; B, Bushman; C, Gorilla. *a*, *b*, *c*, articulations with the calcaneus; *d*, for 'Spring' ligament; *e*, for navicular; *pit*, sub-capitular fossa; *y*, medial tubercle.

FIG. 4. THE LEFT TALUS, ANTERIOR ASPECT. A, Tabūn I; B, Bushman (male). Orientated so that the medial margin is parallel to the sagittal plane of the bone, and resting on its plantar surface. The axis of the capitulum is indicated. *L*, lateral surface; *M*, medial surface. *x*, see text, p. 22.

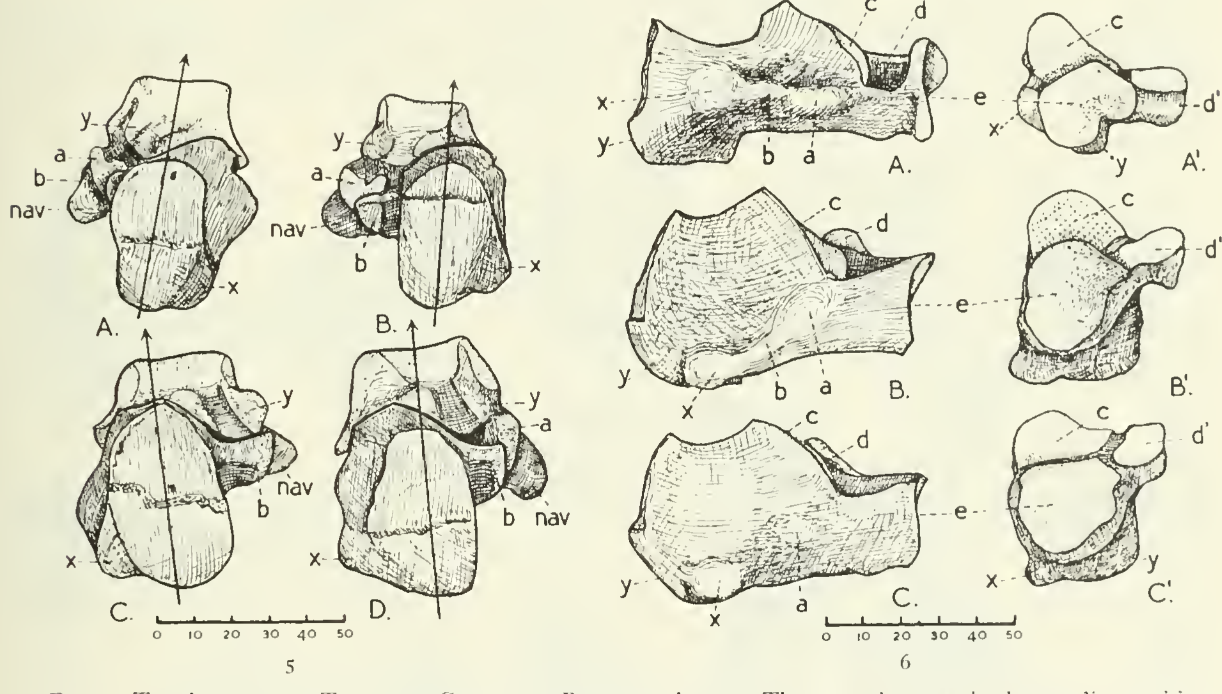


FIG. 5. THE ARTICULATED TALUS AND CALCANEUS, POSTERIOR ASPECT. These are shown as in the standing position and orientated on the sagittal plane of the trochlea. A, Tabūn I, right; B, Bushman (male), right; C, Skhūl IV, left; D, Sikh (male), left. The vertical axis of the tuber calcanei is represented, drawn from the middle of the internal tuberosity (because the tuber in the anthropoid is represented only by this tuberosity) to the midpoint just below the margin of the insertion of the tendo Achilles. *a*, head of talus; *b*, sustentaculum tali; *nav*, navicular; *x*, lateral tuberosity of calcaneus; *y*, medial tuberosity of talus.

FIG. 6. LATERAL AND ANTERIOR ASPECTS OF THE RIGHT CALCANEUS. A, A′, Gorilla; B, B′, Skhūl IV; C, C′, Sikh (male). *a*, peroneal tubercle; *b*, connecting ridge; *c*, posterior facet for talus; *d*, sustentaculum tali; *e*, facet for cuboid; *d′*, sustentaculum tali, anterior facet; *x*, lateral tuberosity; *y*, medial tuberosity.

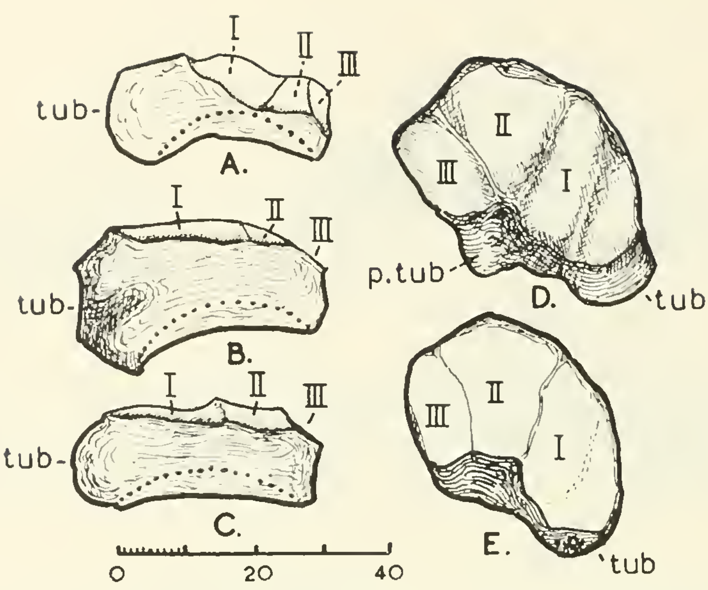


Fig. 7. Os Naviculare Pedis. Dorsal aspect of the right bone of: A, Chimpanzee; B, Tabūn I; C, Bushman (male). Anterior aspect of the right bone of: D, Sikh; E, Skhūl IV. The broken line represents the concavity of the posterior articulation. I, II, III, articulations for the cuneiform bones; *tub*, tuberosity; *p. tub*, plantar tuberosity.

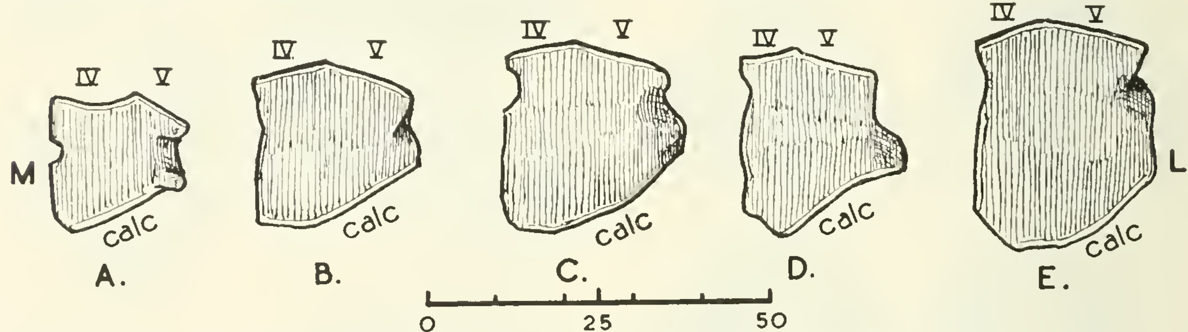


Fig. 8. Os Cuboideum. Dorsal aspect (in outline) of the right bone. A, Chimpanzee; B, Tabūn I; C, Skhūl IV; D, Bushman (male); E, Sikh (male). *calc*, articulation with the calcaneus; IV, V, articulations for metatarsals IV and V; *M*, medial surface; *L*, lateral surface.

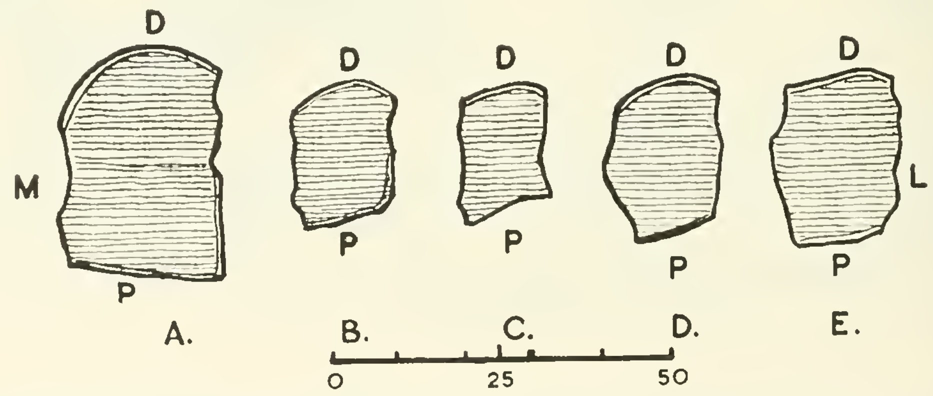
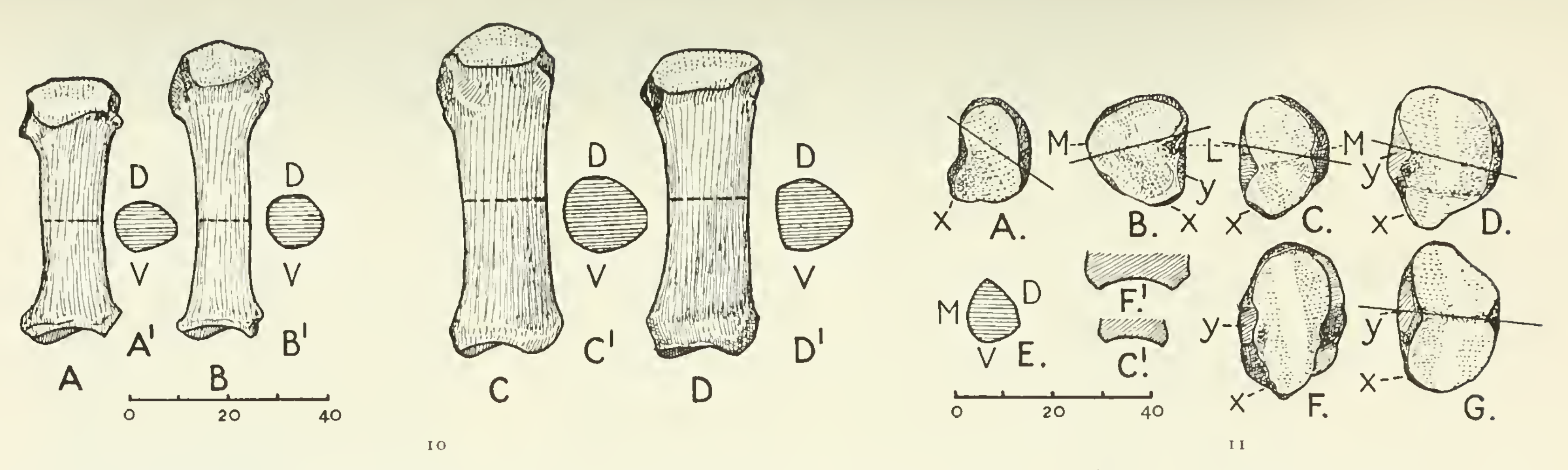


Fig. 9. The First Cuneiform. Horizontal sections of the plantar half. A, Chimpanzee; B, Tabūn I; C, Bushman; D, Skhūl IV; E, Sikh. To show the angle of the distal (metatarsal) articulation (*D*) and for the proximal (navicular) articular surface (*P*). *M*, medial surface; *L*, lateral surface.



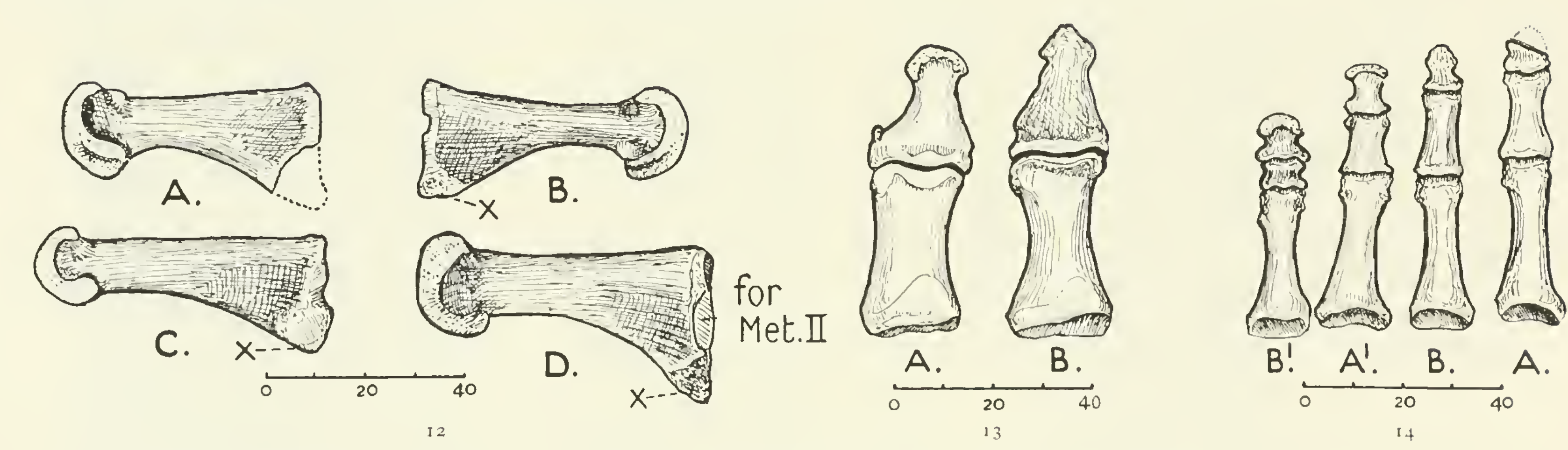


FIG. 10. THE FIRST METATARSAL. Dorsal aspect of the left bone with cross-sections of the shaft at the midpoint. A, A′, Tabūn I; B, B′, Bushman (male); C, C′, Skhūl IV; D, D′, Sikh (male). *D*, dorsal surface; *V*, ventral surface.

FIG. 11. THE FIRST METATARSAL—PROXIMAL ARTICULAR SURFACE. A, Chimpanzee, left; B, Tabūn I, right; C, Bushman, left; D, Skhūl IV, left; F, Skhūl 3, left; G, Sikh, left; E, Gorilla, cross-section at midpoint of shaft; F′, Skhūl 3, transverse section of proximal articulation; C′, Bushman, transverse section of proximal articulation; *D*, extensor surface; *L*, lateral surface; *M*, medial surface; *V*, ventral surface; *x*, tuberosity for attachment of peroneus longus; *y*, indentation on medial margin. The line crossing the proximal view represents the transverse axis of the distal articulation.

FIG. 12. THE FIRST METATARSAL, LATERAL ASPECT. A, B, Tabūn I, left and right; C, Bushman, left; D, Skhūl 3, left. *x*, tuberosity for attachment of peroneus longus.

FIG. 13. THE PHALANGES OF THE GREAT TOE. A, Sikh; B, Skhūl IV. Dorsal aspect of the proximal and distal phalanx, right foot.

FIG. 14. THE PHALANGES OF THE FOOT. Dorsal aspect of the three phalanges of the left second digit. A, Skhūl IV; A′, Sikh. Dorsal aspect of the three phalanges of the left third digit. B, Skhūl IV; B′, Sikh. The reduction of the middle phalanges of the modern toes is very apparent.



CHAPTER IV

THE LEG

TIBIA (Pls. IV, V; Figs. 15–22)

WE propose to record our examination of this bone in some detail because of the light thrown upon the racial nature of the people with which we are dealing and on their posture of body and manner of walking. We may say at once that in the characters of their tibiae the ancient Palestinians are Neanthropic; they agree with living races and differ very markedly from the tibial type found in Spy I (the cast of which we have used as a Neanderthal type) and from all the recorded examples of Neanderthal man in Europe. We have three types to describe: the long and massive, recalling in many traits the tibia of the tall Cromagnons, a medium male type, and a female type (Tabūn I).

The material at our disposal is the following:

Tabūn I: female; right, left; both much crushed but measureable.
Skhūl III: male; left, central two-fourths of the shaft.
Skhūl IV: male; right, left; both practically intact.
Skhūl V: male; right, fragment; left, shaft with a part of the proximal articular surface.
Skhūl VI: male; left, distal two-thirds.
Skhūl VII: female; left, about two-thirds of the shaft, distal to the tuberosity.
Skhūl 4: female; right, central two-fourths of the shaft.

There is a fragment of the shaft of a female left tibia (Skhūl 6), but as this differs in mineralization from all the others and in its characters is altogether modern we have excluded it from our tables. To compare with the Palestinian specimens we include measurements made on a cast of the tibia of Spy I, of a cast of the tibia of the Old Man of Cromagnon, the tibia of the Sikh whose stature was about 5 ft. 6 in., the tibia of a Bushman, and of a gorilla.

General Characters

Among the prehistoric peoples known to us only one—the Cromagnons of Europe—possessed tibiae which in mass and dimensions are comparable to those we are to describe. How greatly they differed from the Neanderthals of Europe will be realized when Fig. 16 is examined. There the longest of the Palestinian tibiae, that of Skhūl IV, is set side by side with three others, those of Spy I, Cromagnon, and of a Sikh. All are orientated on the same plane, to be described presently, and all are depicted from the same aspect, a true lateral profile. The total length of the Spy tibia is 331 mm. Boule estimates that the tibia of La Chapelle was a little longer, namely, 340 mm. The maximum length in Skhūl IV is 430 mm. for the right bone and 434 mm. for the left. If we apply the formula of Pearson (1898) (see Martin, 1928, vol. ii, p. 1070) to these dimensions we obtain a mean tibial stature of 1,813 mm. (71·3 in.); using Manouvrier's tables (Martin, 1928, vol. ii, p. 1069) the result is still more, namely, 1,875 mm. (73·8 in.), which we regard as too great. The longest recorded tibia of the Cromagnon race is that given by

Verneau (1906, t. ii, p. 110), namely, 455 mm. for the left tibia, but as the right is recorded to have been only 452 mm. the former condition cannot be regarded as normal. The mean length for modern European males is 365 mm. The tibia of Skhūl V (the distal articular end is missing) may be estimated to have been somewhat shorter than is that of Skhūl IV, namely, 412 mm., and yet it is the more massive in the diameters of its shaft. Again applying Pearson's formula, we obtain an estimated stature for Skhūl V of 1,765 mm. (69·4 in.); in Skhūl VI, the tibia having been about 405 mm., we obtain a stature of about 1,748·9 mm. (68·8 in.). Thus, the three men were tall, varying from 5 ft. 8·8 in. to 5 ft. 11·3 in. As regards the woman (Tabūn I), the lengths in Table XI (p. 53), when Pearson's formula for women is applied, give a stature of 1,488 mm. (58 in.). It may be that among the Palestinians, as amongst the Cromagnons, there was a sexual differentiation which gave the male a preponderant stature, but even then a woman with a stature of only 4 ft. 10½ in. is exceptional. The length of the other female tibia (Skhūl 4) is estimated to have been 350 mm., which corresponds to a stature of 1,570 mm. (61·8 in.). Boule gives the length of the tibiae of the La Ferrassie woman as 308 and 307 mm., slightly less than in Tabūn I. Thus, we have to note in this, as in many other features possessed by the woman from the Tabūn cave, a trait that links her more closely than the Skhūl males to the Neanderthalians of Europe. Not only in length, but in relative thickness of shaft of tibia, there is a difference to be noted. The European Neanderthal people had thick, short bones: those of Mount Carmel had long and relatively slender bones. In Table XI, line 3, is given the least circumference of the tibial shaft and also in the same table is given the proportion which this measurement makes when compared with the length. In the Spy tibia, for example, the index of robusticity is 26·2; the opposite extreme is illustrated in the Bushman—18·8. In Skhūl IV the index is low—19·8; it is higher in No. VI, higher still in No. V, and reaches 22·2 in the Tabūn woman, who ought—because of her femininity—to have slenderer bones than the male. It is to be noted that in the Cromagnon tibia, used here as a type, the index of robusticity was 23·7, rather higher than in the Tabūn woman. In its shortness and relative thickness the tibia of the Tabūn specimen approaches the Neanderthal pattern of Europe, while in the same respects the males approach the Cromagnon type.

We now proceed to deal with other general features of the tibia, namely, the curvature of its extremities and the planes of its articulations. We soon found, as others must have done, that the methods employed for recording these characters are unsatisfactory, and that if progress is to be made a more accurate technique must be adopted. We must agree to use a fixed plane for the tibia, as for the skull, to make exact records possible. In Fig. 15 diagrams are given to illustrate the methods of measurement we employed. The tibia is placed as in the drawing and its distal end raised until it becomes level with the proximal end of the tibial tuberosity. Such a line represents the axis on which the chief muscles of the thigh (quadriceps extensor) exerts its pull on the tibia. The exact anatomical points employed are indicated in Fig. 15. The tuberosity terminates, as it approaches the knee-joint, in an oval, smooth elevation (Fig. 15, B, x'), this surface being separated from the tendon of the quadriceps by a lubricating bursa; at the proximal boundary of this elevation is a narrow, curved groove; the upper point, x, is the lateral end of this groove (Fig. 15 x). The distal point, y, is situated on the anterior tibial margin of the ankle-joint, at the mid-point of the margin above the joint surface. Having determined these points, a

fine linen thread is stretched from *x* to *y* and fixed locally by wax or plasticine. The bone is placed so as to bring the line *A–B* parallel with the plane *C–D* on which the proximal end of the bone rests (Fig. 15 A).

Our chief difficulty has been to find a suitable vertical or sagittal plane. Such a plane should be determined by points on the shaft. We have to estimate the torsion of the ankle-joint of the tibia. The proximal end of the tibia is usually regarded as fixed and is taken as the basis for determining the torsion of the distal end. We have found that both proximal and distal ends may undergo torsion independently and the kind of torsion can be determined only by taking the shaft as a basis for measurement. In most tibiae of modern Europeans a vertical plane is provided on the lateral aspect of the mid-part of the tibial shaft; the tibia when placed in the horizontal plane is also arranged so that the interosseous line and the anterior border of the shaft (at its mid-point) are placed in the same vertical plane (Fig. 15 B, *A′–B′*). Difficulties arise when we apply this system to anthropoid tibiae and those of certain native races, such as the Bushmen. In section the lateral aspect of the shaft of the tibia, in its mid-part, is convex with the anterior margin rounded and ill defined. Nevertheless, the interosseous and anterior lines can be used to give a vertical plane. In the anthropoid tibia this plane can be found not at the mid-point of the shaft but near the proximal end, a little distal to the tuberosity. Further, the orientation of the tibia in the longitudinal plane has to be determined. We use the innermost points of the medial condyle and of the malleolar process for this purpose.

The tibia being arranged as described, we proceed to determine four characters: (*a*) the direction of the medial condylar surface; (*b*) the degree of torsion of the articular surfaces; (*c*) the transverse planes of the knee-joint, and (*d*) of the ankle-joint. In place of measuring the latter (*c*, *d*) in degrees, we record the relation of the lateral condylar surface to the medial condylar surface, and the same relation between the lateral and medial trochlear surfaces at the distal end. In each case a point at the centre of the articular area is taken as the place of measurement. If the lateral condylar point (or lateral trochlear point at the ankle) is 3 mm. higher than, or proximal to, the medial, we record it as +3 mm., namely, that the lateral articular surface of the tibia, in the planes shown in Fig. 18 and just described, rises 3 mm. above the medial. To bring the condylar surfaces level the distal ends have to be moved towards each other at the ankles, the condition found in bow-legs. On the other hand, the usual condition in modern man is to find an opposite state, the internal area some millimetres higher than the external; to bring them level at the knee-joint the distal ends at the ankle have to be moved away from each other, as in functional degrees of knock-knee.

Having determined the joint levels, we then turned our attention to a very difficult matter, the development of the tibial condyles in a backward direction and the degree of bending of the shaft. We have recorded a figure which gives expression to both these features—development of the proximal end in a backward direction and bending of the shaft. The method of measurement is shown in Fig. 15 A, where *e–f* represents the vertical distance of the highest point on the posterior (lower) aspect of the tibia from the plane of rest, *C–D*. The straighter the shaft, the less the development of the condyles backward, the shorter is the vertical line *e–f*. In order to express this condition relative to the length of the bone an 'index' has been worked out by expressing the *e–f* distance as a ratio of the maximum length (cf. Table XI, line 10).

First, as regards the direction of the medial condylar articular surface: in the Palestinians the average backward inclination is high, 16·5° to 17°. In Spy it is 14°, the same as in the gorilla tibia examined by us. In the Bushman this angle measures 15·5°; in the Sikh and Cromagnon tibiae 8° and 8·5°. The functional significance of this angle of inclination is still obscure.

In determining the degree of torsion of the ankle-joint to the knee-joint we found that the knee is the more steadfast. We took the middle of the shaft as our standard of reference for both joints, knee and ankle. In the gorilla, for example, the proximal end of the tibia is rotated so that the medial condyle has passed backwards and the lateral condyle forwards, until the transverse axis of the knee forms an angle of 6° with the transverse plane as determined by our method of orientation. The distal end has turned in the same direction, so that the medial side of the joint passes backwards and the lateral or fibular side forwards; an internal rotation. The ankle, in the gorilla examined, has rotated inwards to an extent of 20°, but as the proximal end has also rotated in the same direction (to an extent of 6°), the total rotation of ankle to knee is only 14°. In the human tibia the rotation is in an outward direction, bringing the tibial malleolus forwards and outwards and placing the foot in an 'out-toed' position. Rotation of the foot outwards or inwards may also take place at the hip-joint as well as at the ankle; here we are concerned only with the movement at the ankle. In the Spy tibia the outwards rotation at the ankle is 24°, 4° of this being due to an inward rotation of the proximal end of the tibia. In Skhūl IV the total outward rotation is 20·5° in the left and only 18° in the right bone, this being made up as in Spy of a certain degree of rotation inwards at the knee. In the woman from the Tabūn the outward rotation (torsion) in the right foot is 21° (8° at the knee inwards, 13° at the ankle outwards); in the left tibia the torsion is only 5°, but this small amount is certainly due to the broken and crushed state of the distal end of the tibia. In the Cromagnon tibia examined the outward rotation was 16°, in the Bushman 17°, in the Sikh 35° (7° at the proximal end and 28° at the distal end). Thus, neither in Spy nor in the Palestinians do we meet with an approach to the inwards rotation at the ankle seen in the anthropoid tibia; the Palestinians and European Neanderthalians are 'modern' so far as their degree of tibial torsion is concerned. In the modern Australian, on the other hand, a rotation outwards of only 5° is quite common—an approach to the anthropoid condition.

We now come to consider the levels of the articular surfaces of the knee and ankle in a transverse plane so far as these have been preserved on our specimens. If readers will consult Table XI (p. 53) they will find our results so far as they concern the knee. In the Sikh, for example, the lateral condylar surface, with the tibia orientated as described previously, is placed 7·5 mm. below the level of the medial condyle; to bring the two on to the same level the distal end of the tibia has to be moved outwards 40 mm., giving a normal degree of knock-knee. In Spy the opposite is the case: the distal end of the tibia has to be moved inwards to bring the external condyle down to an extent of 6 mm. This is the bow-knee state, certainly nearer akin to the anthropoid state than the knock-kneed. In the gorilla the condyles are level, for in that anthropoid the distal end is not only rotated inwards but is also bent inwards. In the Tabūn woman the lateral condyle of the tibia is the higher, as in the Spy man; in Skhūl IV the two are almost on the same level in both knees, an uncommonly straight-limbed man. The Cromagnon tibia also shows

a certain degree of bow-leggedness. Thus, as far as the horizontal levels of the condyles of the tibia are concerned, the Palestinians are intermediate, the Tabūn woman agrees with Spy, Skhūl IV with the Cromagnon specimen.

There is nothing anthropoid in the Palestinians so far as the transverse plane of the articular surface of the ankle is concerned. In the gorilla the lateral margin is 6 mm. higher (more proximally placed) than the medial margin, corresponding to the development of the outer side of the trochlear surface of the talus. This conformation tends to throw the sole of the foot of the anthropoid inwards for the purpose of grasping. In the Bushman there is a degree of this anthropoid conformation, the outer margin being +3 mm.; in the left ankle of the Tabūn woman there is an almost similar degree but this is certainly due to deformity from crushing. In all the others, Spy, Cromagnon, and Skhūl IV, the margins are almost on the same level.

We now come to deal with the facts concerning the retroversion of the proximal end of the tibia and the curvature of the shaft. The data bear on the 'posterior concavity' of the bone, chiefly due to the great development of the condyles, especially towards the hinder or flexor aspect of the knee. The method we have adopted to measure this character has already been explained (p. 43), as well as the calculation of the index to express its relative amount. Spy is at the head of the column of indices with one of 10·7, due to the massive development of the condyles and the shortness of the tibial shaft. The gorilla follows with 10·2, then comes the right (the better preserved) tibia of Tabūn I with 9·8. Here again we meet with a character which links her to the Neanderthal people of Europe. In Skhūl IV the index for the right bone is 7·6, for the left 8·9, a variation in the same individual enough to convince us that we cannot attach importance to minor variations of this measurement. It is the lowest in the Bushman, 6·3; in the Sikh it is 8·8, in the Cromagnon tibia 8·2, in Skhūl V about 7·3. Thus, the males from Mount Carmel, so far as concerns this character, agree with the modern races of mankind and not with the prehistoric Neanderthalians.

Characters of the Diaphysis

One of the main differences between the human and the anthropoid tibia lies in the form and size of the anterior crest or shin. We have sought to devise methods—not altogether successfully—to measure the development of the crest, firstly in a forward direction (in the antero-posterior plane) and secondly in a lateral direction. Our methods and results (given in Table XII, p. 53) will be best understood by consulting Fig. 16. There the lateral aspect of the Spy tibia is represented in profile B; it is orientated in the manner already described; our base-line is seen to pass between the points already indicated (cf. pp. 42–43). The crest in the middle third of the tibia fails to reach this line—so poorly is the shin developed in the Spy tibia. In the Sikh tibia the crest extends well in front of (above, as represented in the drawing) our datum line (*A–B*); at the middle point of the shaft the crest is 4 mm. beyond our base-line (represented by +4 in Table XII); at the same point in the Spy tibia the crest falls short by 2 mm.—it is −2. Similarly we have noted the amount which the lower part of the shaft of the tibia, at the point where the smallest circumference is taken, falls behind our base-line. In the Sikh it is −3, in Spy −5. Now if the data in Table XII are examined it will be seen that the crest in the Palestinian tibiae is developed in a forward direction to a modern extent (Fig. 16 A, D);

this is also true of the Cromagnon tibia (Fig. 16 C). The crests of Skhūl IV are particularly well developed (+5); they also show the deep hollowing above the ankle which is seen in the Spy tibia. It is important to note that in this character the Tabūn woman (Fig. 17 A), who possesses so many affinities to the Neanderthal type of Europe, is altogether in agreement with the tall Palestinian males. The data given for the gorilla are not directly comparable for reasons we need not go into here.

For estimating the development of the tibial crest in a lateral direction we use the technique illustrated in Figs. 15 B, 18. The first drawing (Fig. 18 A) represents the left tibia of the gorilla, orientated as already described but viewed anteriorly instead of in profile. We found it necessary to use another line or base for our present purpose; the points from which our base thread was stretched are shown in Fig. 15 B; above, instead of the lateral point on the tuberosity, we now take a median point (x')—in the middle of the sagittal line of the upper or proximal part of the smooth or bursal area. The distal point (y) remains the same. It will be observed (Fig. 15 A) that the tibial crest diverges from this line (A'–B') as it descends towards the medial malleolus. In Fig. 18 B the disposition of the crest in the Spy tibia is illustrated; as the crest begins to descend in the proximal half it at first diverges medially as in the gorilla, but before entering the distal half of the tibial shaft, turns laterally towards our base-line. In most modern tibiae the crest crosses this line before it again diverges to reach the medial malleolus. We take two measurements: first the point of furthest divergence in the proximal half (given in line 3, Table XII, p. 53), and the distance of its nearest approach, or amount of overcrossing, in the distal half of the shaft (line 4, Table XII). For instance, the records for the gorilla are −11, −16; those for Spy, −2, 0. That is to say, that in the distal half the crest of the Spy tibia just reaches our base-line. In the Sikh the crest crosses the base-line by 8 mm.—it is +8; in our Cromagnon cast (left) it is +6·5; in both tibia of Skhūl IV it is +3. But in those of the Tabūn specimen all are of a minus amount, as in Spy and the anthropoids. Here again is a point in which the Tabūn woman approaches the Neanderthal type of Europe while the Skhūl men resemble those of Cromagnon. From the cross-sections given in Figs. 19–20 it will be seen that the crest is blunt and rounded in the Palestinians, as it also is in the Neanderthal people of Europe.

We now come to deal with the characters of the shaft revealed by the study of horizontal sections made (1) at the level of the nutrient foramen, (2) at the mid-point of the shaft. Cross-sections of eight tibiae at the level of the nutrient foramen are recorded in Fig. 19. It is the absolute measurements of the diameters (Table XII) rather than the ratio of the one to the other which impress us. Great as are the diameters of the 'sabre-shaped' Cromagnon tibia, it is rivalled by our largest, namely, Skhūl V. As will be seen from our table, the antero-posterior diameter in Skhūl is 46 mm., while in the Cromagnon it is 47 mm., but then the transverse diameter in No. V is 29 mm. against the Cromagnon 27 mm. Skhūl IV falls short a little way of V, but compared with the tall Sikh, No. IV seems massive. In its form, as in the ratios of its diameters, No. VI (male) is altogether modern. The Spy tibia, as regards its diameters, falls below even those of Skhūl VI. The Tabūn tibia, as in so many instances, differs from that of the males; in its antero-posterior diameters it is very similar to that of the Bushman but its width is decidedly greater (Table XII).

Although the diameters at the nutrient level are great, the ratio of the thickness from side

to side compared with that from front to back is such as is met with in modern races; if our table of results is examined it will be seen that most of our specimens fall into the vast middle group in which the transverse diameter ranges from 65 to 70 per cent. of the antero-posterior diameter. Spy I falls into this group; so does the tibia of the La Chapelle man (Cnemic index, 69). The Cromagnon tibiae fall low in the index series (59·5–64·2); so does Skhūl V (63). The tall male from the Grottes des Enfants has shaft diameters of 42 mm. and 29·5 mm., with an index of 70·2, but in contrast to him the almost equally tall Barma Grande No. 1 (male) individual has diameters of 48 and 28 mm. with an index of only 58·3. On the other hand, the Tabūn woman stands high in the series; her left tibia gives an index of 77·4, while Skhūl 4, also a woman, is 71·4. The crushed tibia of Skhūl VII, also a woman, had an index of 80 or more—all the indications point to its having been stouter and rounder than the same bone in Tabūn I. The gorilla has a flat-shafted (platycnemic) tibia (54·5), but the nature of the platycnemia is not the same as in the human tibia.

Our studies have thrown some light on the nature of platycnemia. It is produced by the formation of a bony pilastre formed on the hinder aspect of the shaft and laid down between the medial margin of the shaft and the interosseous border. It leads to an increase of the antero-posterior diameter.

The formation of the posterior pilastre of the tibia is well illustrated in Fig. 16. In the tibia of the Sikh, for example, the pilastre is confined to the proximal third of the shaft and supports the condyles of the tibia. At the distal end a posterior pilastre or strut strengthens the shaft above the ankle-joint. These two parts of the pilastre are easily recognized in the tibia of Skhūl IV (Fig. 16 A); in the Cromagnon tibia (Fig. 16 C) the proximal and distal parts of the pilastre have become joined by the formation of a connecting or intermediate part. The complete posterior pilastre is very evident in Spy (Fig. 16 B), in Tabūn I (Fig. 17 A), and the Bushman (Fig. 17 B).

The pilastre is well developed in all the Skhūl tibiae and at first we confused its proximal part with the oblique or popliteal ridge which serves to give attachment to the tibial head of the soleus. We have traced all stages in the development of the pilastre—from a stage where it is confined to the proximal fourth of the bone to one in which it forms a support between the articular extremities of the bone. As a rule, the popliteal line is very imperfectly marked in the Skhūl tibiae; usually it is a rough, slightly depressed, linear area—if it is discernible at all. The tibial pilastre is formed between the areas which give origin to the tibialis posterior (laterally) and the flexor digitorum longus (medially). Although we can offer an anatomical explanation of the tibial pilastre (and platycnemia) we are still at a loss to explain its functional utility. Enough to remark that the pilastre is a structure which was well developed among the ancient Palestinians, as it was at a later date among the Cromagnons.

We have attempted to give a 'pilastric index'—a figure which represents the degree of development of the pilastre. If the sections in Fig. 19 be examined it will be seen that the lateral surface between the anterior border and the interosseous border is placed vertically. If the antero-posterior diameter is taken in this vertical plane, so much of the measurement lies anterior to the interosseous line, so much behind that line. The amount behind the line is made up chiefly by the pilastre. Therefore the ratio of the post-interosseous part of the diameter to the whole will give an indication of the development of the pilastre. In Table XII, line 10, these ratios are given, taken at the level of the nutrient

foramen. The ratios at the nutrient level vary from 24·2 to 41·0 among the ancient Palestinians; a similar range occurs amongst the Cromagnons; in the Spy tibia it is 55·1, a high figure. The post-interosseous ratio in the gorilla is 62·1, but this is made up not by the pilastre seen in the human tibia but by another element altogether.

In Table XII, lines 8 and 9, are given the diameters at the mid-point of the tibial length. As in the case of those taken at the level of the nutrient foramen, the Skhūl bones are remarkable for their absolute rather than for their relative measurements. They agree with those taken from modern men of tall stature. The proportions of the antero-posterior diameter formed by the pilastre element of the bone are given in Table XII, line 11.

All who have had occasion to describe the tibiae of Neanderthal man in Europe have noted the bluntness and indefiniteness of the chief borders of the shaft. In Figs. 19 and 20 students will be able to note the condition of the borders (anterior, medial, lateral) in the Skhūl bones. These borders are certainly more definitely marked in all the specimens than in the Spy tibia, while in Skhūl VI they are as sharply marked as in Cromagnon or modern tibiae. Yet in Skhūl V they are relatively blunt, and in Skhūl VII, too, they are so. A drawing of Skhūl V given in Fig. 17 C serves to give some idea of its massiveness. In none of the bones is the interosseous border raised into a linear ridge; sometimes its position is difficult to detect.

In connexion with the tibia of Skhūl V a note may be made on the difficulty in recognizing the position of the nutrient foramen. A similar difficulty was met with in Nos. III and VI. We found that with a great development of the pilastre the foramen may be moved from the usual site on the lateral aspect of the bone under the origin of the tibialis posterior to a position on or near the popliteal line or ridge, and in this altered position the foramen is always small in size. We observed the same shifting in the pilastred tibia of the Bushman.

Articular Extremities

Our predecessors have been so concerned with the angles and the indices of the proximal end of the tibia of prehistoric man that they have failed to note the chief feature in which the knee of Neanderthal man differs from that of modern man. It concerns the relation of the tuberosity of the tibia—the structure through which the tendon of the quadriceps muscle exerts its power on the tibia. In the Spy tibia, for example, the tuberosity is placed far forwards as regards the articular condyles of the tibia. This is in harmony with the forward position of the trochlear surface of the femur and the thickness (antero-posterior diameter) of the patella which plies in the trochlear surface. The space between the quadriceps tendon and the anterior surface of the condyles of the tibia is filled, in the living state, by the sub-patellar pad of fat. We may speak of the tibial surface against which the pad rests as the 'sub-patellar area'. In Neanderthal man this area is extensive and is inclined backwards to a much greater extent than in modern man. The physiological advantage of the forward position of the tuberosity is also clear; it serves to give the muscle a more powerful action in extending the knee—as in rising from a crouching position or in extending the leg forward in walking. On the other hand, the approximation of the tuberosity to the condyles in the modern tibia gives greater rapidity of movement, with less power.

Our method of using the base-line *A–B* (Fig. 15 A) provides us with a means of

measuring the relationship of the tuberosity to the articular condyles. The point *x*, it will be remembered (p. 42), represents the lateral end of a crescentic groove which bounds the upper limit of the tuberosity. We take the most forward point on the articular surface of the medial condyle to mark the anterior limits of the articular surface of the proximal end of the tibia. This point we will speak of as '*p*' (Fig. 15 A). Now in the Spy tibia the point *p* is situated 30 mm. above *x* and 20 mm. behind it—in the plane on which we orientate the tibia.[1] In the tibia of the gorilla the point *p* is only 23 mm. above *x*, but it is the same distance behind it as in the Spy tibia, namely, 20 mm. It is this relationship which gives the anthropoid aspect to the proximal end of the Neanderthal tibia. If we turn to a modern bone, such as that of the Sikh, *p* is the same distance above *x* as in Spy, namely, 30 mm., but it is only 10 mm. behind—half the amount in Spy. Turning to Skhūl IV, the only wholly complete tibia we have of Palestinian man, we find the relationships are as in the modern tibia; the point *p* is 28 mm. above *x* and only 10 mm. behind it. In this, as in so many other features, the Palestinian tibiae are modern. Unfortunately the proximal ends of the tibiae of the Tabūn woman are crushed, but there are characters still apparent which make us believe that its features were those of Spy rather than of the Sikh.

We have to take into consideration the length of the tibia in relationship to the position of its tuberosity. We regard the distance between the points *x* and *p*— seen in the projected profile—as indicating the relationship of condyles to tuberosity. This measurement represents the hypotenuse of the two measurements already given. For example, the Spy tibia gives measurements of 30 mm. and 20 mm.; the hypotenuse joining these amounts is 35·5 mm. The length of the Spy tibia is 331 mm.; the hypotenuse represents 10·7 per cent. of the tibial length and may be taken as an indication of the 'set-back' of the articular condyles of the tibia. The index for the gorilla is almost the same, namely, 10·2. In the Sikh, on the other hand, the index is only 8·8 and in Skhūl IV it is slightly less, namely, 7·9. Thus, the Skhūl tibia in this essential point differs from the Neanderthal type and agrees with the modern.

Regarding the characters of the proximal end of the tibia, there are only a few observations to be made. It will be noted that although the Spy tibia is 100 mm. shorter than Skhūl IV (both are males), yet the dimensions of the condyles in Spy are only slightly less than in Skhūl IV (Table XIII, p. 54). Indeed, as regards the distal extremity, the Spy dimensions are the greater. Thus in the Palestinian long bones we do not meet with extremities which are exaggerated in size relative to length of shaft. The Skhūl tibia in this respect agrees with the Sikh and the Cromagnon. Unfortunately—saving the distal end of the right tibia—the extremities of the tibiae of the Tabūn woman are much crushed. But it will be seen from the data given in Table XIII that the extremities in Tabūn I were relatively not greater than in the Bushman. The Tabūn woman had not the exaggerated terminal ends to the long bones met with in the Neanderthals of Europe.

We kept records of the items which go to make up the transverse breadth of the proximal end of the tibia—the part occupied by the medial condyle, the intercondylar space, and the lateral condyle—but nothing instructive emerged. For example, the transverse diameter (84 mm.) of Skhūl IV (left) was made up thus: medial condyle 36 mm.; inter-

[1] The point *p* is *below* the plane *A–B* and to the right or left of the point *x* shown in Figs. 16, 17, where the specimens are placed horizontally. The description refers to the tibia set in an upright position.

condylar space 14 mm.; lateral condyle 34 mm. In the Spy tibia the corresponding figures are as follows: 33, 15, 31 mm.

In Fig. 21 we compare sections of the articular condyles of Skhūl IV, the Spy, and the Sikh tibiae. The flatness, sometimes even a convexity of the lateral articular surface in the Neanderthal people of Europe, has been noted by many observers. The flattening or hollowing of this surface is present in Skhūl IV and to a lesser degree in Tabūn I. Certainly in their general contour and disposition the condylar articular surfaces of Skhūl IV agree with the Sikh rather than with Spy I.

The relationship in level of the condylar surfaces has been already discussed (p. 44-45). We would draw attention here to a feature of the Spy tibia, namely, to the high ridge, arising from the medial tibial spine, which passes forwards on to the lateral aspect of the articular area of the medial condyle. This marked elevation is absent in the modern tibia; this is also the case in the Skhūl tibia.

The intercondylar spine is large in the Palestinian tibiae. In Skhūl IV it rises 11·5 mm. above the level of the lowest part of the medial condylar area. Its height in Spy is 10·5 mm.; in Tabūn I 9 mm.; in the Sikh 10 mm.

It may be said that in their distal ends the Skhūl tibiae are modern in their characters, not Neanderthal. The only instance which might be construed in an opposite sense is in the case of the Tabūn woman. Even in her case, when all features are taken into consideration, she leans towards the Skhūl or modern type of ankle-joint more than towards the Neanderthal type.

Perhaps the most characteristic feature of the distal end of the Spy tibia is its medial malleolus. In shape and dimensions it has many affinities to the malleolus of the gorilla (Table XIII, p. 54). On the whole, the Skhūl malleolus is modern in its characters and yet it has peculiarities of its own. In Fig. 22 drawings are given of the malleolus in three tibiae—Spy, Skhūl IV, and the Sikh. It will be seen that in the Skhūl tibia, as in the Sikh, the malleolus has undergone a degree of degeneration, confirmed by the dimensions recorded in Table XIII. To understand the nature of the changes seen in these drawings one must remember that the tibial malleolus is made up of two functional elements: (1) the articular element forming a guard for the ankle-joint as well as a site for the attachment of ligaments; (2) a 'pulley' element for the tendon of the flexor hallucis longus—which plies along its posterior and lower borders in lower primate forms. The articular element makes up the anterior and lateral part of the malleolus; the 'pulley' element the posterior and medial. Now in the gorilla and in Spy both malleolar elements are greatly developed and almost indistinguishable. In the Skhūl tibia the articular element has sunk down almost to the same level as the pulley element, while in the Sikh (representing *H. sapiens*) it is the pulley element which has degenerated. Here we may regard the Skhūl malleolus as intermediate to the forms seen in Spy and the Sikh.

We have noted the accessory facets on the distal end of the tibia which come into contact with the neck of the talus in complete flexion of the ankle-joint. In this matter there is no essential difference in the form or extent of the facet in Spy, Skhūl, Tabūn, Bushman, or Sikh. In all of them there is, on the in-turned lower margin of the tibia, an oval, convex, articular facet (Fig. 22 *a*) which comes in contact with the lateral aspect of the neck of the talus. In all of them there is another contact facet (not articular) situated in

the angle formed by the anterior lower margin of the tibia and the anterior border of the malleolus. This comes in contact with the dorsal aspect of the neck of the talus.

FIBULA (Pl. V; Figs. 23, 24)

Fibula.

The following specimens were at our disposal:

Tabūn I, female; right, almost complete with only the head missing; left (four fragments), middle third of the shaft (121 mm.), the proximal end of shaft with crushed head, and the distal extremity.

Skhūl IV, male; right, complete; left, almost complete.

Skhūl III, male; left, proximal two-thirds. 236 mm.

Skhūl V, male; left (two fragments). The larger represents the shaft from beyond the mid-point nearly to its distal termination. Measures 205 mm.

Skhūl VII, female; left (?), two fragments of the shaft, the larger much crushed.

For comparison we have used the fibulae of the Bushman to compare with Tabūn I and those of the tall Sikh to compare with the tall Skhūl males.

We are brought at once to a consideration of two contrasted types of shaft, the rounded or sub-cylindrical, seen in Tabūn I and in the man of La Chapelle; and the flattened, fluted type, seen in the highest degree in the Cromagnon males and also in Skhūl IV, indeed, in all the males from the Skhūl. In the Krapina Neanderthal specimens there was a certain degree of flattening; so, too, in La Ferrassie No. 2. In the gorilla, as will be seen from the sections reproduced in Fig. 23, there is flattening and fluting, but the shaft maintains its primitive three-sidedness in the upper two-thirds; in the distal or lower third it becomes flattened laterally and is two-sided. We are not inclined to attach a high morphological value to the presence of fluting and flattening; nevertheless, we have to be influenced by the fact that the Skhūl males show features which attach them to the Cromagnon type, while Tabūn I retains the form usually attributed to Neanderthal man. One uncrushed portion of the proximal part of the fibular shaft of Skhūl VII has a fuller, more rounded, triangular section than the Tabūn woman. The Skhūl woman undoubtedly had a stronger fibula (a–p., 10·5 mm., transv., 11 mm.). We shall see that the Tabūn fibulae have certain characters in common with the Skhūl men—characters which modern men do not possess. The Palestinian fibulae are also remarkably straight, but in this respect the fibulae of the Sikh and the Bushman are almost equally so.

Although the maximum total length could be measured on only one specimen (Skhūl IV, right) we have every reason to think that as regards length, the fibula of the Palestinians held the same relationship to length of tibia as in modern man. As regards the strength of shaft, we have worked out an index of robusticity by using the ratio obtained from the circumference at the mid-point relative to the total length. All are essentially slender, the index being about the same as in the Bushman and below that of the Sikh, which is by no means a big-boned type (Table XIV, p. 54). In this relationship it is well to note the fact that the extremities of the bones are not relatively great (Table XIV). It is remarkable that the head of the fibula in Skhūl IV should be smaller than in the shorter limbed Sikh. As regards the distal extremity (the lateral malleolus), Skhūl IV is relatively and absolutely greater than is the Sikh. The lateral malleolus of Tabūn I differs from that of the Bushman in shape (Fig. 24), but the measurements in the Bushman are greater.

In connexion with the relatively small development of the head of the fibula, an observation may here be interpolated bearing on the form taken by the articular facet on the lateral condyle of the tibia for its reception—an observation purposely omitted from our account of the tibia. The articular facet on the tibiae of Skhūl IV (both sides) is not smooth, but rough, as if there had been no synovial cavity—only a direct ligamentous band. In the right tibia of Tabūn I part of the facet remains; it is smooth and its synovial cavity was apparently in direct communication with that of the knee-joint, a primitive feature met with in many forms of primates.

It is unnecessary to give a detailed account of the surfaces and borders of the shaft; we have made sectional drawings at three points of the shaft: at the distal end of the proximal fourth, at the mid-point, and at the proximal end of the distal fourth. These sections are orientated on the antero-posterior plane given by the base of the articular surface of the lateral malleolus. A common plan can be recognized running through all sections.

We were particularly struck by the characters of the articular aspect of the lateral malleolus (Fig. 24). It will be noted that in the case of the fibula of Tabūn I the articular surface occupies only the anterior half of the entire medial aspect, while in the malleolus of the Bushman the posterior or non-articular area, with its enclosed fossa, has been reduced to a small fraction of the medial area. The same relationship, although in a lesser degree, is seen when the malleolus of Skhūl IV is compared with that of the Sikh. In both Palestinians the posterior area and fossa are actually and relatively large (they give attachment to the lateral ligament of the ankle-joint), while in the two modern malleoli, representative of two diverse types of humanity, they are actually and relatively small. We have evidence here that the Tabūn woman, differing as she does in many features from her male companions, is yet like them in her essential features. Another small piece of evidence afforded by the fibula is corroborative of this view. We noticed a peculiar muscular area on the posterior medial aspect of the fibula, in the middle fifth of its length. This area lies between those which give origin to the tibialis posterior and the flexor hallucis longus. It is enclosed by the medial border, dividing as it descends and then reuniting lower down on the shaft. This enclosed area is very clearly marked on the Tabūn fibula; it is not present in either of the Skhūl IV bones or in Skhūl V, but it is definitely present in the other bone available for examination, Skhūl III. It is on such points as this that we have confidence in our conclusion—that, great as is the individual variation, the group is made homogeneous by the possession of a series of common characters.

Table XI. TIBIA

	Tabūn I		*Bushman*	*Skhūl IV*		*Skhūl V*	*Skhūl VI*	*Spy I*	*Cro-magnon*	*Sikh*	*Gorilla*
	R	L	L	R	L	L	L	L	L	L	L
Greatest length M 1	(315·0)	310·0	350·0	430·0	434·0	(412·0)	(405·0)	331·0	375·0	394·0	294·0
Artic. length M 2	298·0	(295·0)	333·0	406·0	412·0	..	..	305·0	362·0	373·0	266·0
Least circum. M 10*b*	70·0	74·0	66·0	85·0	86·0	90·0	84·0	87·0	89·0	79·0	69·0
Index of robusticity	22·2	23·4	18·8	19·8	19·8	21·8	20·7	26·2	23·7	20·1	23·5
Inclination of head*	16·5°	(25°)	15·5°	17·0°	17·0°	..	..	14·0°	8·5°	8·0°	14·5°
Torsion M 14	21·0°	..	17·0°	18·0°	20·5°	..	..	24·0°	16·0°	35·0°	14·0°
Relative height of condyles†	+3·0	+7·5	−3·0	+0·5	0·0	..	..	+6·0	+1·5	−7·5	0·0
Trochlear heights‡	+0·5	(+3·5)	+3·0	+1·0	+1·0	..	..	+0·5	+0·3	+1·0	+6·0
Post. projection of head§	31·0	24·0	22·0	33·0	39·0	(30·0)	..	35·5	31·0	35·0	30·0
Index of curvature‖	9·8	7·7	6·3	7·6	8·9	(7·3)	..	10·7	8·2	8·8	10·2

Greatest length of Skhūl III, (405·0); Skhūl VII, (345·0); Skhūl 4, (350·0).

* Inclination of the internal condyle to the axis of the shaft. Corresponds to Martin 13, but determined in a manner explained in the text, pp. 42–43.

† Relative height of the centre of articular surface of the external condyle above (+) or below (−) the corresponding point of the internal condyle. The bone is orientated so that the medial margins of the internal condyle and the malleolus are in the same vertical plane.

‡ Height of the lateral part of the trochlear surface above (+) or below (−) the corresponding point on the medial trochlear surface (cf. p. 43).

§ Measurement made to estimate the extent to which the condyles project behind the mid-point of the hinder aspect of the shaft. The manner of taking this measurement is explained in the text. It is intended to replace the very inaccurate method used to estimate retroversion of the proximal end of the bone (cf. p. 43).

‖ An index of curvature representing the proportion which the amount of posterior projection of the head forms to the total length of the bone (cf. p. 43).

Table XII. TIBIA

	Tabūn I		*Spy I*	*Bushman*	*Skhūl IV*		*Skhūl V*	*Skhūl VI*	*Skhūl III*	*Skhūl 4*	*Cromagnon*		*Sikh*	*Gorilla*
	R	L	L	L	R	L	L	L	L	R	L	L	L	L
Ant.-post. extension of crest:*														
at mid-pt. of shaft	+4	+4	−2	+1	+5	+5	..	..	..	..	+3	+3	+4	+6
at least circumfer.	−2	0	−5	−2·5	−6	−4	..	..	..	..	−2·5	−4	−3	−4
Medio-lateral extension of crest:†														
max. in prox. half of shaft	−5	−6	−2	−6	0	0	..	..	..	..	0	−2	0	−11
min. in distal half of shaft	−4	−2	0	+2	+3	+3	..	..	..	..	+6·5	+1	+8	−16
Shaft diameters:														
Nutrient foramen:														
ant.-post. M 8*a*	(28·0)	(31·0)	39·0	29·0	40·0	38·0	46·0	40·0	(42·0)	35·0	42·0	47·0	35·0	33·0
transverse M 9*a*	24·0	24·0	26·0	19·0	27·0	27·0	29·0	26·0	28·0	25·0	27·0	28·0	27·0	18·0
Cnemic index	85·7	77·4	66·6	65·6	67·5	71·0	63·0	65·0	66·6	71·4	64·2	59·5	77·0	54·5
Mid-point of shaft:														
ant.-post. M 8	27·0	28·0	33·0	27·0	32·0	32·0	39·0	34·0	35·0	29·0	37·5	39·0	32·0	28·0
transverse M 9	20·0	21·0	25·0	17·5	25·0	25·0	26·5	23·0	23·0	22·0	26·0	26·0	24·0	17·0
'Pilastric' index:‡														
at nutrient level	35·7	41·9	48·6	55·1	41·0	31·5	41·3	34·2	..	24·2	40·4	47·0	19·3	62·1
at mid-pt. level	28·6	28·6	39·3	37·0	18·7	22·5	45·4	26·4	..	27·5	35·1	32·3	11·1	64·2

* For a description of the technique used, see p. 45.

† For a description of the technique used, see p. 46.

‡ The definition of this index is given on p. 47.

Table XIII. TIBIA

	Tabūn I		*Bush-man*	*Skhūl IV*		*Spy*	*Sikh*	*Cro-magnon*	*Skhūl VI*	*Gorilla*
	R	L	L	R	L	L	L	L	L	L
Width prox. end M 3 . .	(66·0)	. .	64·0	83·0	(84·0)	79·0	78·0	78·0	. .	76·0
Ant.-post. diam. of internal condyle M 4*a*	39·0	(39·0)	40·0	(52·0)	54·0	51·0	53·0	46·0	. .	50·0
Ant.-post. diam. of lateral condyle M 4*b*	. .	(33·0)	36·0	(45·0)	47·0	46·0	40·0	42·0	. .	43·0
Max. width distal end M 6 .	41·0	(36·0)	44·0	50·0	51·0	54·0	48·0	48·0	50·0	50·0
Ant.-post. diam of distal end M 7	31·0	(33·0)	32·0	41·0	41·5	41·0	38·0	39·0	37·0	35·0
Length of malleolus* . .	12·5	. .	14·5	15·5	16·5	15·5	15·0	15·5	15·0	24·0
Ant.-post diam. of base of malleolus	25·0	. .	21·0	28·0	28·0	34·0	26·0	31·0	27·0	27·0
Trans. diam. of malleolus .	11·2	. .	12·0	14·0	14·0	18·5	13·0	14·0	13·0	20·0

* The amount of projection beyond the medial, trochlear margin of the tibia.

Table XIV. FIBULA

	Tabūn I		*Bush-man*	*Skhūl IV*		*Sikh*	*Skhūl III*	*Skhūl V*
	R	L	R	R	L	L	L	L
Actual length	(283·0)	. .	. .	. .	. .	. .	(236·0)	(207·0)
Max. length M 1	(300·0)	. .	338·0	414·0	(410·0)	389·0	. .	(400·0)
Circ. at mid-pt. M 4 . .	28·0	28·0	34·0	44·0	46·0	48·0	45·0	41·0
Ind. robusticity*	(9·3)	. .	10·0	10·6	. .	12·3	. .	. .
Ant.-post. diam. at mid-pt. M 3 (2)	10·6	10·0	11·0	26·0	27·0	16·5	15·0	15·5
Trans. diam. at mid-pt. M 3 (1)	9·5	10·0	9·5	9·0	9·0	12·5	10·0	10·0
Index of flattening . . .	89·6	100·0	86·3	34·6	33·3	75·7	66·6	64·5
Ant.-post. diam. of neck . .	8·0	9·2	8·0	13·5	14·0	13·0	14·0	. .
Trans. diam. of neck . .	7·0	7·0	8·0	8·0	8·0	11·0	8·5	. .
Ant.-post. diam. of head (max.)	. .	. .	21·0	25·0	. .	28·0	27·0	. .
Trans. diam. of head M 4 (1)	. .	. .	16·5	20·0	(21·0)	24·0	(16·0)	. .
Ant.-post. diam. of base malleol.	21·0	21·0	22·0	28·0	28·0	26·0	. .	. .
Trans. diam. of base malleolus M 4 (2)	13·0	12·0	16·0	20·0	21·0	18·0	. .	. .

* This index is defined on p. 51.

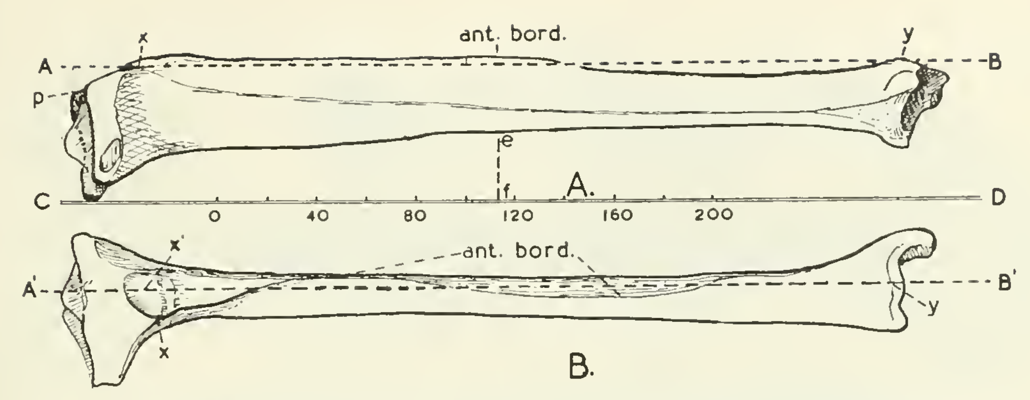


Fig. 15. Tibia. A, lateral aspect; B, anterior aspect. To show the method of orientation and the planes employed—*A–B* and *C–D* (anterior and posterior) and *A′–B′* (sagittal). *x*, upper point; *y*, lower point; *x′*, median point of tuberosity; *e–f*, maximum distance from *C–D* to posterior aspect of shaft; *p*, most anterior point on articular margin of medial condyle; *ant. bord.*, anterior border or crest of tibia. For an explanation of the method of orientation, see pp. 42–3.

Fig. 16. Tibia, Left Lateral Aspect. A, Skhūl IV; B, Spy I; C, Cromagnon (Old Man); D, Sikh. *tub*, tuberosity; *os. l.*, interosseous line. Other letters as in Fig. 15. A stippled line on the head of the bone represents the articular surface of the medial condyle.

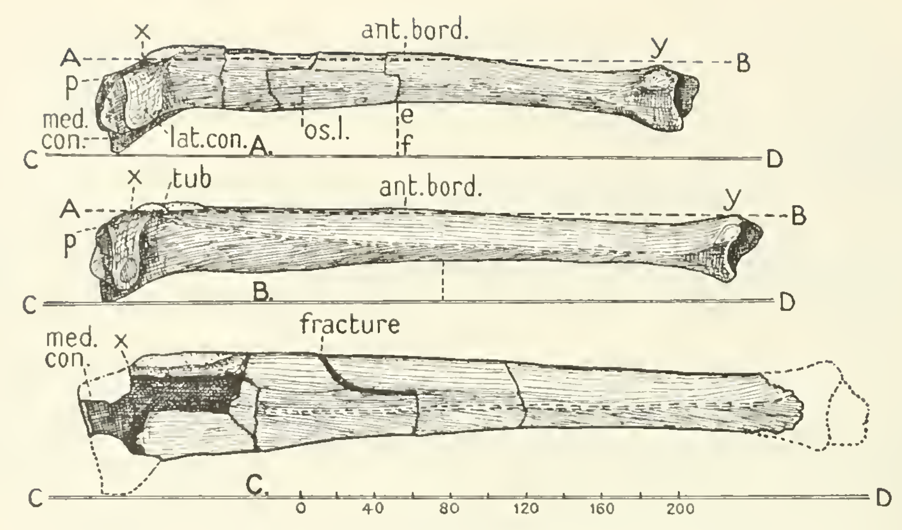


Fig. 17. Tibia, Right Lateral Aspect. A, Tabūn I; B, Bushman; C, Skhūl V (left bone reversed). *lat. con.*, lateral condyle; *med. con.*, medial condyle. Other letters as in Figs. 15 and 16.

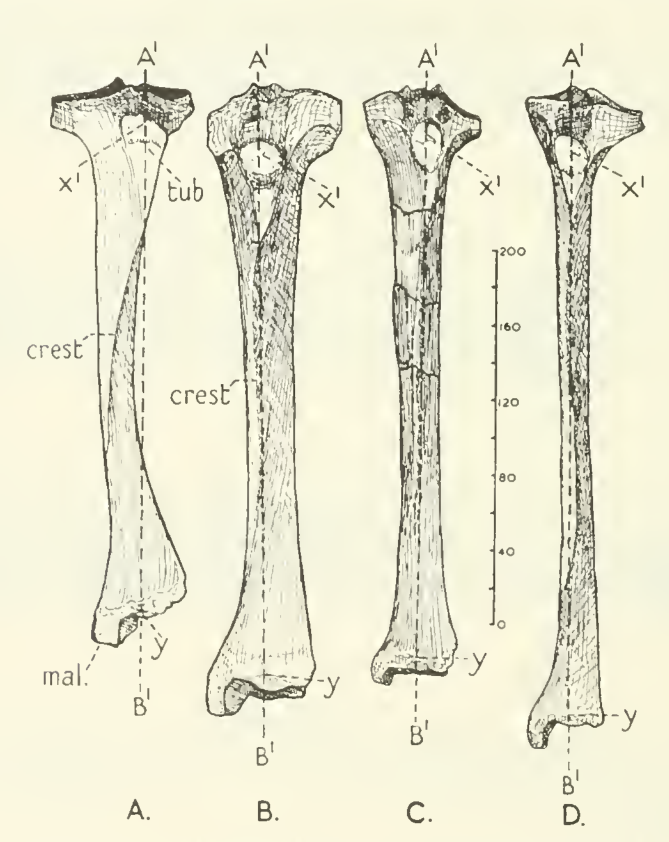


Fig. 18. Tibia, Anterior Aspect of the Left Bone. A, Gorilla; B, Spy I; C, Tabūn I (right bone reversed); D, Bushman. *A′–B′*, sagittal plane; *x′*, median point of tuberosity; *y*, lower point; *crest*, anterior border; *mal.*, malleolus; *tub*, tuberosity. See Fig. 15 B.

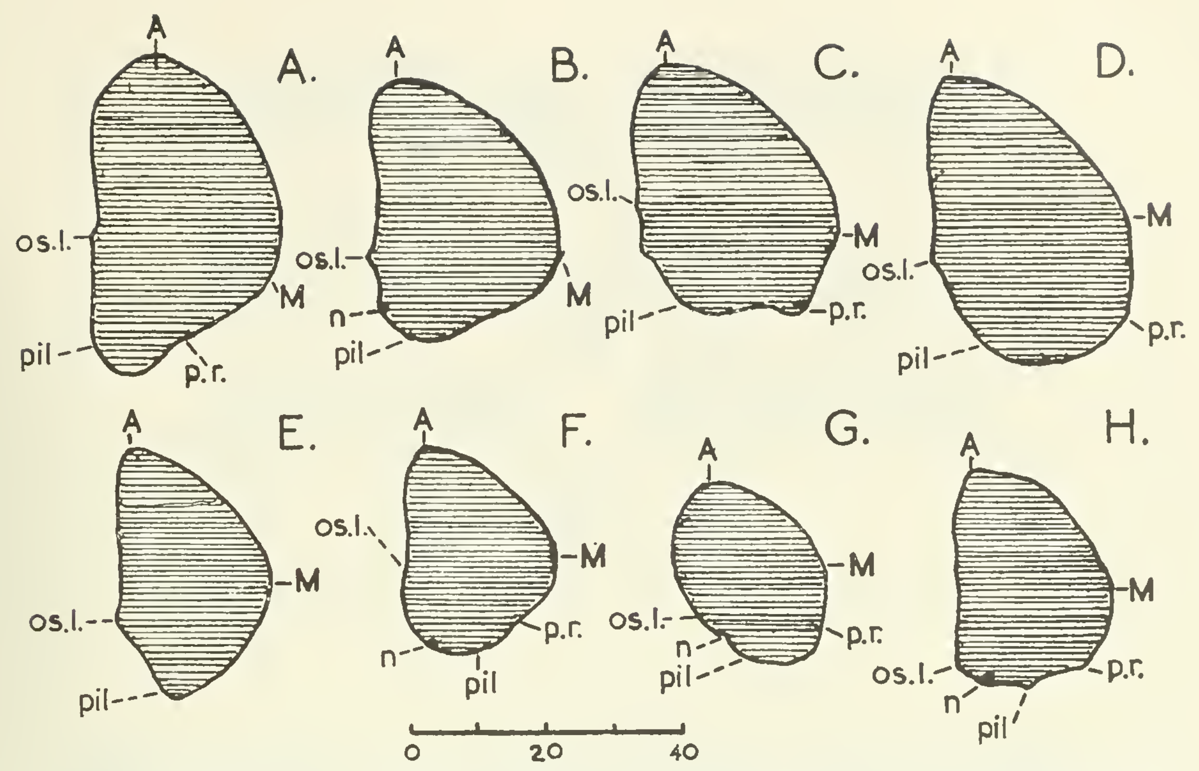


Fig. 19. Transverse Sections of the Shaft of the Left Tibia at the Level of the Nutrient Foramen, viewed on the Proximal Surface. A, Skhūl V; B, Skhūl IV; C, Spy I; D, Cromagnon; E, Skhūl VI; F, Tabūn I; G, Bushman; H, Sikh. *A*, anterior border; *M*, medial border; *os. l.*, interosseous line; *n*, nutrient foramen; *pil*, pilaster; *p.r.*, popliteal ridge or impression.

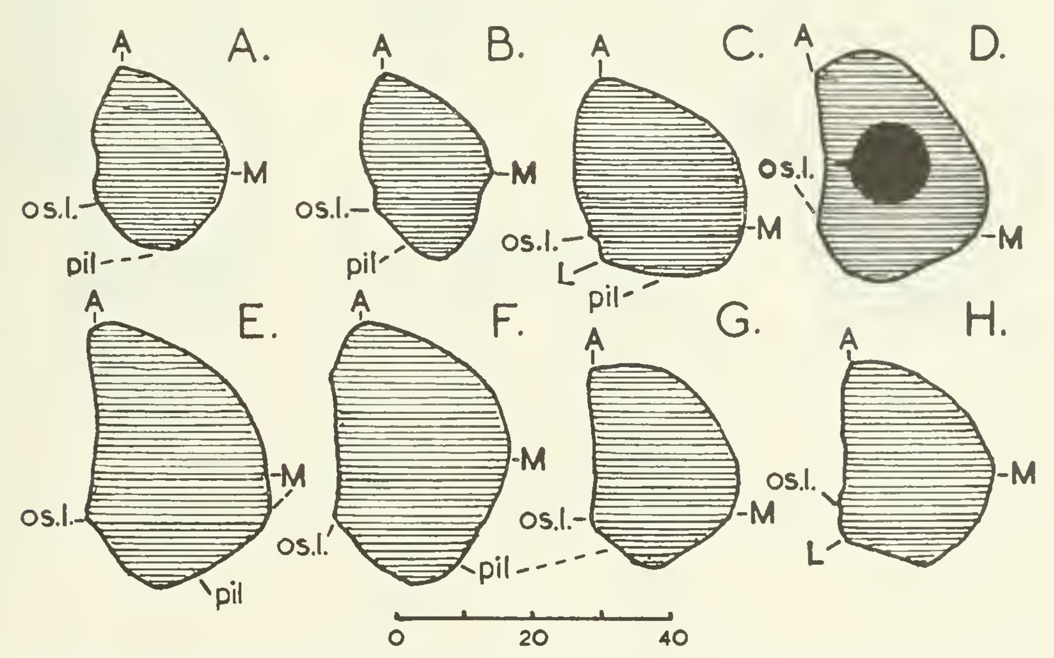


Fig. 20. Transverse Sections of the Shaft of the Left Tibia at the Midpoint, viewed from above. A, Tabūn I; B, Bushman; C, Spy I; D, Skhūl IV; E, Cromagnon; F, Skhūl V; G, Skhūl VI; H, Sikh. *L*, lateral border. Other letters as in Fig. 19. The medullary cavity is indicated in D.

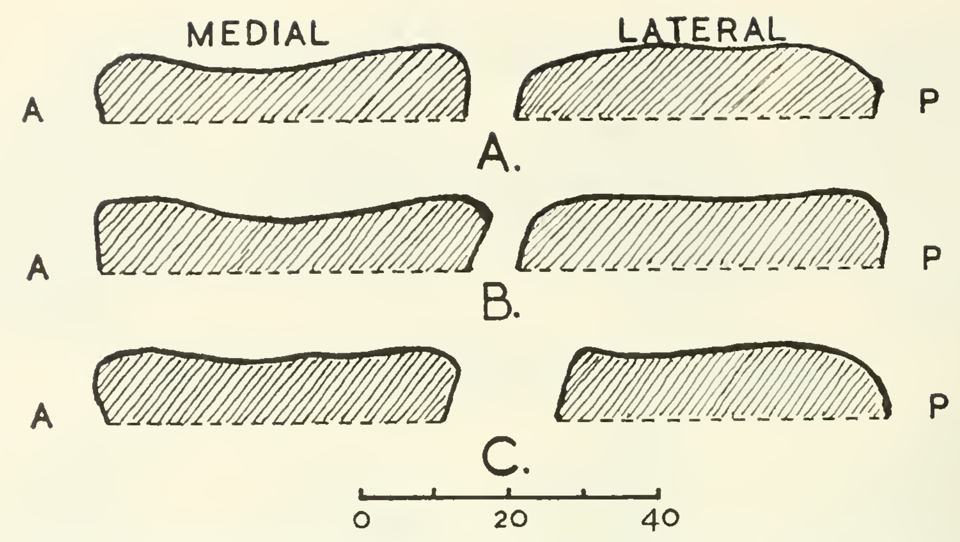


FIG. 21. ANTERO-POSTERIOR SECTIONS OF THE ARTICULAR SURFACES OF THE MEDIAL AND LATERAL CONDYLES OF THE TIBIA. A, Spy I; B, Skhūl IV; C, Sikh. *A*, anterior margin; *P*, posterior margin.

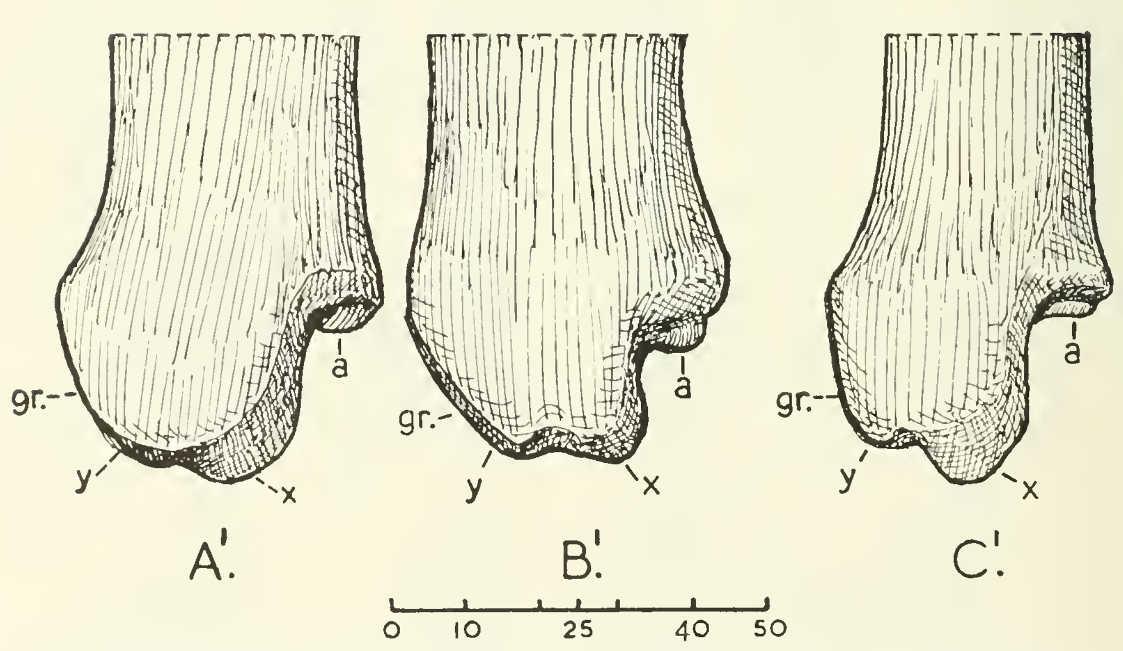


FIG. 22. THE TIBIAL MALLEOLUS. A, Spy I; B, Skhūl IV; C, Sikh. *x*, articular element of malleolus; *y*, 'pulley' element of malleolus; *gr.*, groove for the tendon of the flexor longus pollicis; *a*, accessory facet.

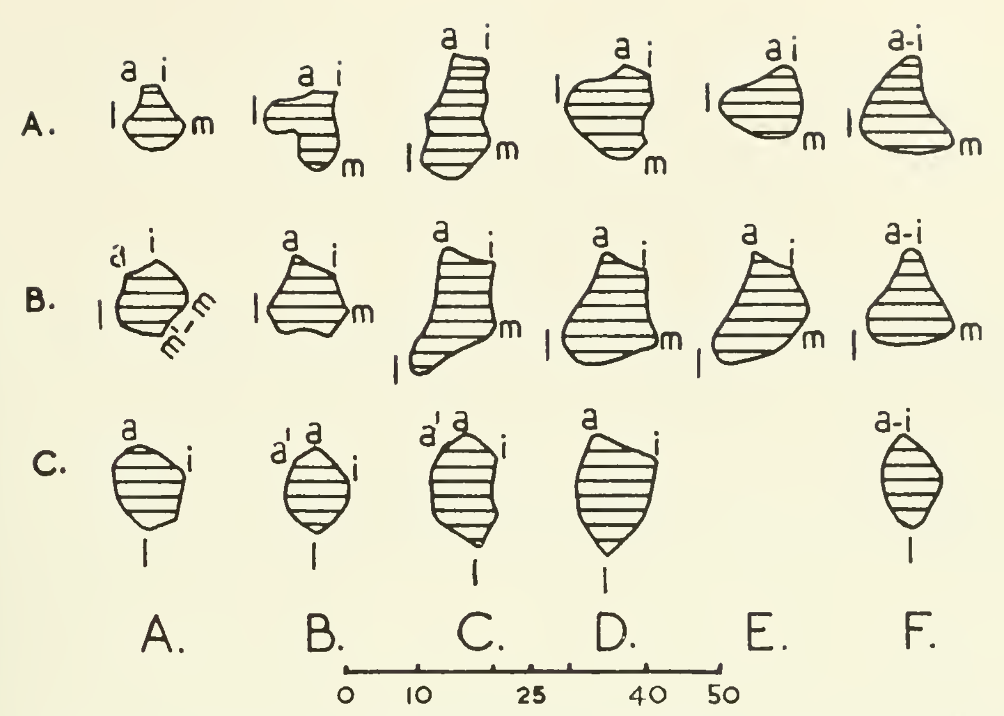


FIG. 23. THE FIBULA. Transverse sections of the left fibula at three levels. Sections are viewed from above. A. Upper series. Taken at the distal end of the proximal fourth of the bone. B. Middle series. Taken at the midpoint. C. Lower series. Taken at the proximal end of the distal fourth of the bone. A, Tabūn I; B, Bushman; C, Skhūl IV; D, Sikh; E, Skhūl III; F, Gorilla. All are orientated on the same antero-posterior plane, namely, that of the base of the articular surface of the lateral malleolus. *a*, anterior border or crest; *i*, interosseous line; *l*, lateral border (in distal sections this border becomes the posterior one); *m*, medial border; *m′–m*, section at middle of Tabūn fibula represents a division of the medial border, the division enclosing a space described in the text; *a–i*, fusion of the anterior border and the interosseous line. *a′*, lateral branch of anterior border.

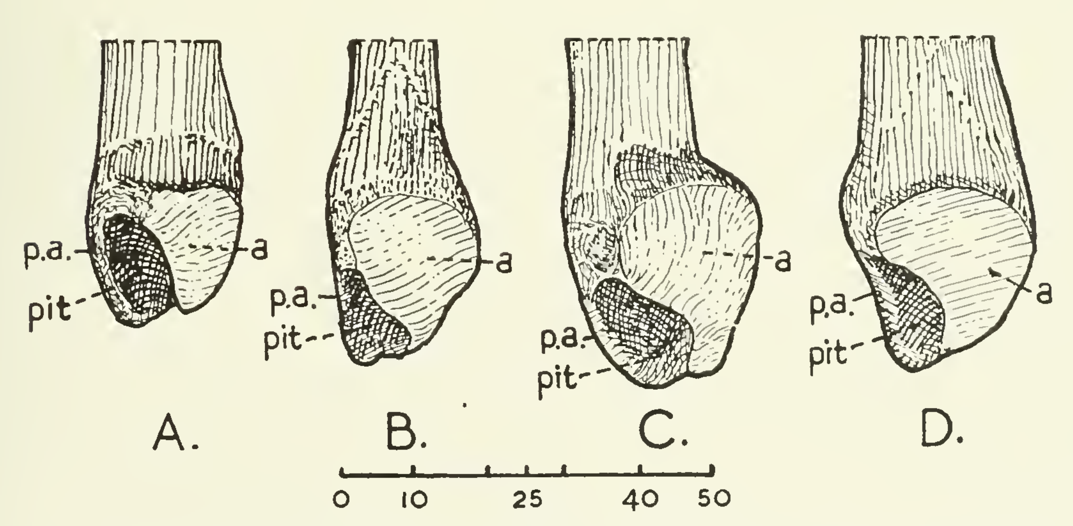


FIG. 24. THE FIBULA. The articular surface of the left lateral (fibular) malleolus. A, Tabūn I; B, Bushman; C, Skhūl IV; D, Sikh. *a*, articular area; *p.a.*, post-articular area; *pit*, post-articular pit.



CHAPTER V

THE THIGH (PATELLA; FEMUR)

PATELLA

WE have three specimens, the right of Tabūn I, somewhat damaged, and the right and left of Skhūl IV, both intact. There is also a fourth specimen, Skhūl 2 (p. 8), but as this is not fossilized in the sense that the others are and does not agree with them in character, we do not include it in our description, regarding it as an intrusion from the upper stratum of the deposit.

We append a table of measurements (Table XV, p. 67), giving also data relating to the patellae of Cromagnon man, Neanderthal man, and modern man. We also give vertical and transverse sections which are more instructive than the measurements (Fig. 25). The photographs of the trochlear aspect of the right patella of Skhūl IV, Tabūn I, and a Sikh are shown in Plate VII D.

Perhaps the most characteristic feature of the Palestinian patella is brought out in the transverse sections (Fig. 25). The median vertical ridge (*a* in lower series) is the vertex of the two-sided articular elevation which plies in the trochlear groove of the femur. Its height is best measured from a base-line which joins the lateral and medial edges of the articular surface (Fig. 25, lower series). The height of this ridge above the base-line is 10·5 mm. in Skhūl IV; 8·6 mm. in the Sikh; 8 mm. in Tabūn I, and 7·2 mm. in the Bushman. The ridge is known to be high in the patellae of the European Neanderthals; it is not only absolutely and relatively high in the Palestinians but, as will be observed in the sections, the articular ridge has the same transverse contour in Skhūl IV as in Tabūn I—another evidence of racial identity—in spite of their great difference in stature.

As may be observed in the sagittal sections (Fig. 25 A, upper series) the median patellar ridge is concave from above downwards in Skhūl IV; the depth of the concavity is 2·8 mm. A slightly marked concavity is also present in the Bushman's patella, while the two others (Tabūn I and the Sikh) are irregularly plane.

When the articular aspect of the Sikh's patella is examined, there are seen, as is the case in the patella of most Europeans, seven facets, three forming pairs on each side of the median vertical ridge—the middle pair being the most extensive. The seventh occupies an area on the medial side of the articular surface. The seventh area, which is seen in the transverse section of the Sikh's patella (Fig. 25 B, lower series D, *m–m'*) comes into contact with the adjacent margin of the medial condyle in complete flexion of the knee. This facet is not apparent in Skhūl IV, Tabūn I, or the Bushman. In Skhūl IV and Tabūn I the seventh or medial facet is represented by an extensive and concave area.

In the upper lateral quadrant of the modern human patella the margin is sometimes marked by a wide notch or bay; this was markedly the case in the Spy patella. In the patella of the Sikh it is indicated by a straight flat marginal area on to which the articular surface extends. In Skhūl IV this marginal area is very extensive (23 mm. long by 7 mm. wide) and was apparently covered by articular cartilage. The marginal area extended in Skhūl IV so low down that it was cut in the transverse section (Fig. 25 B, lower series

c, *l–l′*). This area may have been present in Tabūn I, but unfortunately the margin is defective at the site it would have occupied if present.

The dimensions are given in Table XV (p. 67). As regards width, the Skhūl patellae fall below those of Spy and of the men of Cromagnon and are equal to the smaller Krapina examples; as regards height the Skhūl is equal to the Cromagnon and greater than the Neanderthalians of Europe. In thickness the Skhūl patellae are equal to that of La Chapelle, but not so thick as in Spy and Krapina. This is remarkable when we remember how much taller the Skhūl men were than the Neanderthalians of Europe. In dimensions, that of Tabūn I agrees with the Bushman specimen, and yet in their anatomical details the bones are very different. From a consideration of all these facts we conclude that the patella of the Palestinians was anatomically more akin to the Cromagnon than to the Spy type.

THE FEMUR (Pls. VI, VII; Figs. 26–36)

The following is a list of the material at our disposal:

Tabūn I. The right bone practically complete; its distal end has been compressed. The left bone is fragmentary and incomplete. The bones are those of a woman just over 5 ft. in stature (1,537·5 mm.).[1]

Tabūn E*a*. This is the oldest fossil fragment at our disposal (p. 10) and consists of about three-fifths of the shaft of the right femur extending from the base of the trochanter minor to a point about 75 mm. distal to the mid-point of the bone (Fig. 29). We attribute it to a man about 5 ft. 4 in. (1,625·6 mm.) in stature. The bone is of similar colour to that of Tabūn I but more heavily mineralized (Figs. 27, 29, 35).

Tabūn 1. This represents rather more than the distal half of the shaft of a right femur, extending from about 20 mm., above the mid-point of the bone, almost to the lateral condyle. We attribute it to a young woman under 5 ft. in stature (1,506 mm. is our estimate). The bone has the same brown colour as the other Tabūn specimens, but shows an almost flinty appearance at sites of fracture.

Skhūl III. Part of the shaft of a left femur, the fragment being 252 mm. in length, extending from about 68 mm. above the mid-point to about 55 mm. from the lateral condyle. We estimate the bone when entire to have been about 515 mm. in length, belonging to a tall man with a stature of about 5 ft. 10 in. (1,781 mm.). It has the greyish straw-yellow colour, which most of the other Skhūl bones have, with the same degree of mineralization.

Skhūl IV. Both right and left bones are almost intact; they are those of a strongly built man about 5 ft. 8·4 in. (1,738 mm. average of right and left bones) in stature (Pl. VI; Figs. 26, 28, 32).

Skhūl V. The right bone is represented by the proximal three-fourths, while the left bone extends from the base of the trochanter minor to the knee-joint, the lateral condyle being the most damaged (Pl. VII; Fig. 28). By comparing the right and left bones we estimate that the original maximum length was 518–20 mm., indicating a tall man with a stature of 5 ft. 10 in. (1,787 mm.), according to Pearson's formula for stature calculated from the femur length.

Skhūl VI. The left bone is almost complete save for fragments missing from both

[1] The basis of this estimate is given on p. 58. The stature calculated from the tibia is considerably less (p. 42).

extremities. The right bone is represented by the greater part of the shaft (315 mm.) extending from the base of the trochanter minor to the middle of the popliteal area. The left bone measures 477 mm. (max. length). We attribute it to a man about 5 ft. 7·2 in. (1,709 mm.) in stature (Pl. VII). These bones are of a rich brown, almost mahogany colour, and somewhat similar to the Tabūn specimens. Like Tabūn 1, the bone has a flint-like appearance when exposed at points of fracture (Fig. 26).

Skhūl VII. A right bone from which the head and neck are broken away, part of the head being joined to a fragment of the acetabulum. The distal end is much crushed, and so is part of the proximal shaft. We estimate the original length to have been about 438 mm. and attribute it to a woman whose stature must have been about 5 ft. 2 in. (1,580 mm.). The colour is a lighter brown than that of No. VI. The bone, although now hard, has a cheese-like appearance in some of its parts.

Skhūl VIII. The shaft of a right femur of a child about 10 years of age. The part of the bone preserved measures 202 mm., and extends from the distal end of the gluteal impression to a short distance above the condyles. The original length we estimate to have been about 265 mm. The colour is greyish brown, almost straw colour.

Skhūl IX. The proximal part of a remarkable left femur, the shaft being missing beyond the gluteal impression. It is cemented so solidly within the acetabular cavity that it cannot be detached. The attribution of sex to this specimen is somewhat uncertain, features both of the pelvis and of the femoral head and neck indicating a female, but after a consideration of all the characters of the preserved portions of the skeleton and skull we are agreed that this individual was a male. The grounds on which stature has to be inferred are uncertain, but we feel confident that the original length must have been at least 450 mm., and the stature 5 ft. 5·3 in. (1,659 mm.).

Skhūl 7. Fragment of the left shaft (Fig. 34 D), 200 mm. in length and representing the central half. The original length may have been between 440 and 450 mm.; its characters are definitely male. It is of the colour and consistency of most of the Skhūl fossils. On its surface are pits, evidently caused by the teeth of one of the larger carnivores.

Skhūl 8. Fragment of the shaft of a left femur extending from the gluteal impression to about the mid-point of the bone. It measures 122 mm. in length and its surface shows marks of gnawing both by carnivores and rodents. This fragment is not so deeply mineralized as those so far described, but its characters are consistent with those of other Skhūl femora. It is probably a woman's bone.

Skhūl 9. Fragment of the shaft of a left femur; its length is 87 mm., its characters female. It bears the lower part of the linea aspera. It, too, has been gnawed, the surface being deeply pitted. In colour and consistency it is similar to Skhūl 8.

Skhūl 10. Fragment of a left bone, 88 mm. in length, representing the region carrying the lower end of the linea aspera and upper part of the popliteal area. The characters are male. Like Nos. 8 and 9 it is not deeply mineralized.

Thus we have more or less complete femoral representation of 15 individuals, 13 of which are adult, 2 children (Ch. XX); of the 13 adults, 8 are males, 5 females; 3 come from the Tabūn cave, 12 from the Skhūl cave.

For purposes of comparison we have employed casts of the right and left femora of Neanderthal man (Düsseldorf), of Spy man, and the bones of a tall male Australian, of a Bushman and of a Sikh. Verneau's (1906) data concerning the tall Cromagnons has

been referred to, for, as we shall see, there are many and striking points of resemblance between the tall Cromagnon males and the men of Skhūl. Also we have had to pay particular attention to the femora of the Tabūn woman, because in her femora as in so many of her other characters she tends to depart from the Skhūl type and to approach that of the European Neanderthal. Yet we find that her femur has much more in common with the Skhūl type than with that of Neanderthal.

The Femur as a Whole.

Length. Various measurements and estimates of length, maximum and oblique, are given in Table XVI (p. 67) with estimates of stature based on Pearson's formulae. It is at once apparent that we are dealing with a tall race of men, with a bodily conformation very different from the Neanderthalians of Europe—short and stout men. The longest femur, 518 mm., is that of Skhūl V; we have seen that the femur of Skhūl III must have been almost as long. Then follows in order, Skhūl IV, 494 mm. (left); Skhūl VI, 477 mm. The statures of the four men run from 1,709 mm. (5 ft. 7·2 in.) to 1,787 mm. (5 ft. 10 in.). Three men, Tabūn E*a*, Skhūl IX, and Skhūl 7, were apparently of about average stature, 1,656 mm. (5 ft. 5·2 in.), and the shortest Skhūl people surpassed the tallest European Neanderthalians.

Of the six women, only one provides full evidence regarding her stature—namely Tabūn I. The Pearson formula, applied to her femoral length, gives a stature of just over 5 ft. (1,537·5 mm.). The other Tabūn woman (1) was also short. On the other hand, the Skhūl women were somewhat taller, Skhūl VII being about 5 ft. 2 in. (1,580 mm.); Skhūl 8 probably about 5 ft. 5·5 in. The likelihood is that there was a large sex difference amongst the Skhūl Palestinians as amongst the Cromagnons. The man from the Grottes des Enfants described by Verneau had a femoral length of 526 mm. with an estimated stature 5 ft. 11 in. (1,803 mm.), while a woman from the same cave had a femur length of only 400 mm. giving her an estimated stature of 4 ft. 11 in. The sexual contrast in stature among the fossil Palestinians was almost equally great.

It is not only in actual length that the Palestinian femora differ from those of the Neanderthalians of Europe. In relative thickness of shaft and relative size of the articular extremities the Carmel femora resemble those of modern man and differ from the true Neanderthal type represented by the femora of Spy, La Chapelle, and Neanderthal (Düsseldorf). This is best illustrated by the length-thickness index based on a comparison of the circumference of the shaft at its mid-point with the natural length of the femur (Table XVI, p. 67). The mid-circumference in the Neanderthal femora is so great as to form 21·2 per cent. of the oblique length of the bone; in the Spy femur the ratio is still higher, namely 22·2 per cent. Compare with these measurements made on modern bones; the Australian male, with his slender thighs, has a length-thickness index of only 17·3; the Bushman of 17·8; the Sikh 18·5. This index, amongst the ancient Palestinians, falls within the modern range. It is highest in Skhūl V (20·5) and lowest in Skhūl IV (17·9). It will be noted that the Tabūn woman is modern, not Neanderthal, in the length-thickness index. We shall see, while dealing with the articular extremities of the femur, that the Palestinian, in the relative dimension of these, agrees with the modern man and differs from Neanderthal man.

Torsion and Angles. In Table XVI (p. 67) we record measurements made of three angles, (*a*) the neck with the shaft; (*b*) the 'torsion of the neck' or the angle which the

head and neck form with the horizontal plane on which the femur rests; (*c*) the horizontal plane which the knee-joint forms with the shaft. In all of these observations we meet with a wide range of individual variations, the range being not materially different from that met with in human races both ancient and modern. In estimating the neck-shaft angle and degree of torsion there is a large personal equation. We have used a modified technique based on that described in Prof. Karl Pearson and Dr. Bell's (1919) Memoir on the femur. It will be noted that our estimates for the angle of torsion in the Spy and Neanderthal femora are 5° to 10° larger than those usually given. We have noted in the femur, as in the tibia, that the degree of torsion depends not only on that taking place between the proximal end and the shaft, but also between the distal end and the shaft.

The Shaft of the Femur.

Degree of Bending. Orientation of the Shaft. In all our drawings of the femur (Figs. 26, 27, 28, 32, 33), which have been made in true projection, we have orientated the bone in three planes: the bone is placed on a horizontal plane, covered with millimetre paper, the linea aspera and flexor surface being directed towards the paper. The hinder ends of the condyles (lateral and medial) are placed in the same transverse plane, the bone being thus in its 'natural' position. We then raise the shaft into a truly horizontal position by following the instructions given by Martin (Femur 27) for measuring the 'bending of the shaft'. To take the measurement described by Martin the shaft is looked at in true profile, and the proximal and distal points which mark the ends of the bend on the extensor or anterior surface are located. These 'terminal' points (x and y) can be decided with some degree of precision, when the bone is examined in true profile (see Fig. 26). The condyles being placed on the table as described, we raise the proximal end of the bone until the proximal terminal point (x) is on the same horizontal level as the distal (y) and then fix the bone on the table in this position. It is just as necessary to agree on a standard plane for femora as for skulls; unless all the drawings are made with the object placed in a standard position, they cannot be compared.

One of the most striking features of the European Neanderthal femur is the forward curvature of the shaft. In Fig. 26 A is shown a lateral profile of the right Neanderthal femur; x, y, indicate the terminal points of the arch. The distance x–y represents the total length of the base of the arch (315 mm.); the height of the arch is represented by the subtense c–d (15·5 mm.); the ratio of the subtense to the base is 4·9. The data for the curvature of the Palestinian femora are given in Table XVII A (p. 68), where it will be seen that there is an extreme degree of variability in the amount of curvature, ranging from 1·9 in the Tabūn woman to 6·2 in a Skhūl male (No. VI). It is possible that the shaft of Tabūn I has been flattened by soil pressure, but it could never have been so great as in the Spy or Neanderthal femora. In Skhūl IV (the best preserved specimens) the index of curvature is only 2·7 and 2·4 (Fig. 26 B), much less than in modern Australian femora (Fig. 26 C). The degree of curvature in Skhūl VI is altogether remarkable (Fig. 26 D).

In Skhūl IV the summit of the curvature is flattened; opposite the flattened section the linea aspera attains its most extreme development (Fig. 26 B). It is noteworthy that the linea aspera is most developed in the region of curvature, showing that it serves as a strengthening and supporting pillar.

Another way of indicating the difference in curvature of the Palestinian femora and

those of the true Neanderthal type is shown in Fig. 26. A vertical is dropped from the highest point that the linea aspera reaches above the table (Fig. 26, *e–f*). This line measures 52 mm. in the Spy femur, being 12·1 of the femoral length (Fig. 28 A). In the Skhūl IV (right) femur, shown in Fig. 28 B, the height of the linea aspera is only 42 mm., representing 8·4 of the total length. The most curved Skhūl femur (VI) has a subtense of 48 mm., being 10 per cent. of the total length of the bone. The greater ratio of the Spy femur is due to two factors, the small development of the linea aspera and the great backward projection of the femoral condyles, as well as to the curvature of the shaft. In this feature the Skhūl femora resemble modern femora.

Platymeria and Stenomeria of the Femur.

We are now to deal with sections of the shaft of the femur, showing degrees of flattening (platymeria) and narrowing (stenomeria) at three levels, (1) subtrochanteric; (2) at the mid-point; (3) at a supracondylar level (40 mm.) (Tables XVII A, XVII B, p. 68). At a glance the tables will show that we meet with a surprising degree of variation at all three levels. In the left femur of Skhūl V, for example, we find a degree of stenomeria even at the upper level (index 103·2), while at the same level in Skhūl IX an extreme degree of flattening—namely, 67·3. In the Spy femur the corresponding index is 73, in the Neanderthal right femur, 81·1. The actual index provides no basis for a racial distinction, and yet, when we compare an actual section, a distinction in outline can be recognized (Fig. 31, upper series).

At the mid-point level we meet with an even greater degree of variability. In Skhūl V, for example, the antero-posterior diameter is equal to 142·5 per cent. of the transverse, an extreme degree of stenomeria. In Skhūl VIII (child), on the other hand, the ratio is only 94·1—pronounced platymeria. We give also the data for the supracondylar diameters. Here again we meet a considerable range of variation. The Skhūl femora show a greater degree of flattening than do the true Neanderthal, but the range of the two overlaps. Of prehistoric femora, only those of the tall Cromagnon men described by Verneau provide us with pilastring of the linea aspera and stenomeria of the mid-shaft comparable to the corresponding features of the Skhūl femora.

The Tabūn Fragment (E*a*).

Before considering the varying forms and dimensions shown by the sections of the femoral shaft it may be well to consider the characters of the most ancient of the osseous remains from the Tabūn cave, namely, the fragment known as Tabūn E*a*. It comes from below the base of the Levalloiso-Mousterian deposits, from the uppermost of the Acheulean layers (p. 10). Its medial profile is shown in Fig. 29 as well as sections made at the sites shown (*A′*, *B′*, *C′*). The fragment measures 225 mm. and extends from the base of the neck to some distance beyond the mid-point. It shows one feature which is remarkable in a bone so ancient, namely, the bony flange or ridge (Fig. 29, *mf*), which ascends on the medial aspect of the proximal part of the shaft in front of the trochanter minor. We regard this ridge as a supporting bony pilastre, carrying the weight falling upon the head and neck to the medial side of the shaft. This medial femoral ridge is often developed to an extreme degree in the femora of Neolithic and Bronze Age Europeans. By extending the width of the proximal part of the shaft this helps to produce

a flattened appearance. On the lateral aspect of the upper shaft—in front of the gluteal impression—is another wave-like projection of bone which also serves to increase the subtrochanteric width. Although the region of the gluteal impression is damaged in Tabūn E*a* there is clear evidence that the pre-gluteal elevation was pronounced. This structure is also prominent and distally placed in the femur of the Tabūn woman; she also has the medial femoral pilastre moderately developed. In a Skhūl man (No. IX) both of these structures are developed to an extreme extent, giving a high degree of platymeria. Section C (Fig. 29) shows these structures in the subtrochanteric region of Tabūn E*a*. The actual measurements are moderate in amount, width 32 mm., thickness (*a–p* diameter) 25 mm., the latter being 78·1 per cent. of the former, a moderate degree of flattening. In Fig. 30 A is shown the corresponding section of Tabūn I. The dimensions are rather less (23 × 30·5 mm.), giving 75·4 as the index of flattening. One may well regard the differences as sexual in nature, Tabūn I being female, and Tabūn E*a* probably male. We shall see that with one exception (Skhūl IX) all the Skhūl specimens show a much less degree of flattening. In one case, Skhūl V, there is actually stenomeria.

Near the original mid-point of the shaft of Tabūn E*a* the dimensions are moderate, namely, transverse diameter 28 mm., antero-posterior, 26 mm., the latter being 92·8 per cent. of the former. The shaft is flattened. In Tabūn I at the same point (Fig. 30 B), the corresponding dimensions are 27 × 23·2 mm., giving an index of flattening of 87. In the third Tabūn specimen (Tabūn 1) there is still flattening (Fig. 29 D); the index is 91·6.

In all the Skhūl specimens, with the exceptions of Skhūl VIII and Skhūl 9, the relations of the diameters are reversed, the antero-posterior diameters exceeding the transverse at the mid-point of the diaphysis. Although the region of the linea aspera is damaged in Tabūn E*a*, enough remains to show that it was not elevated into a ridge. The three Tabūn femora are flattened and the linea aspera is a rough strip rather than an elevation. These are characters which must be kept in mind in determining the relation of the Tabūn to the Skhūl community.

In Fig. 30 A is shown a section of the femur of the Tabūn woman at the subtrochanteric level. On the section can be recognized the medial femoral flange (*mf*), the lateral gluteal flange or elevation (*gf*), the gluteal impression, and the wide rough area for muscular attachment between that impression and the vastus line. In the same figure (Fig. 30 D) is shown a corresponding section of the wide and flattened femur of Skhūl IX. The medial flange is enormous; the gluteal flange is also well developed, and again there is a wide rough area between the vastus line and the gluteal impression. In Fig. 31 A, upper series, *A*, a section at the same level is shown of the femur of Skhūl IV. The medial flange is not big but is indicated. The gluteal flange is almost absent and the antero-posterior diameter is 80 per cent. of the transverse. The sections of the Tabūn and Skhūl femora should be compared with those taken from true Neanderthal femora, Spy and Neanderthal (Fig. 31 A, upper series B, C). There is no trace of the medial femoral flange in the latter; the shaft is rounded. The gluteal flange and impression, on the other hand, are highly developed in both sections shown, particularly in the Neanderthal femur. Then in Fig. 31 A, upper series D, is shown a transverse section of an English femur of a man living at an early phase of the Iron Age. The medial flange

is clearly differentiated. A comparison of all these sections leads to the conclusion that the Palestinian femora have a closer resemblance to those of modern man and that in this point the Tabūn woman makes no approach to the Neanderthal type of Europe.

In Fig. 31 B, middle series, is given a series of sections of the shaft of the femur at the mid-point. These sections bring out the contrast in the outline of the femora of the tall Skhūl men and the European Neanderthal type represented by the men of Spy and Neanderthal. In the tall Skhūl men the shaft of the femur has become compressed from side to side and at the same time the region of the linea aspera becomes the site of a pilastering which reaches record dimensions in Skhūl V. It is possible that the tall Cromagnon males show an equal or even greater degree of compression and pilastering than the Skhūl femora. Unfortunately Verneau made no record of the mid-point diameters of the femora. But seeing that two of the men described by him had femora which exceed the Skhūl femora in length and also in subtrochanteric dimensions it is probable that they had a large linea at the mid-point level. Martin gives the mid-pilastric index for Cromagnons as 111·6, whereas in Skhūl V the index rises to the record figure of 142·5. In form of femoral shaft the Skhūl people link themselves to Neanthropic races, particularly to the Cromagnon type of the species. They differ in this matter from the European form of Palaeoanthropic man.

Yet not all the Skhūl femora are compressed and pilastred. Some, like the Tabūn femora (Figs. 29 A, D; 30 B), are rounded in section, with a low linea aspera. This is also the case (Fig. 31 B, middle series G) in one of the male femora of Skhūl (No. 7). Sections of two modern femora at the mid-point are shown in Fig. 31 B, middle series D, H.

Sections across the femoral shaft, made 40 mm. proximal to the upper limit of the condyles, are depicted in Fig. 31 C (lower series). An inspection of these and of the measurements in Tables XVII A, B (p. 68) fails to find in the absolute and relative dimensions of the supracondylar shaft any point which serves to distinguish the Palestinian from the Neanderthal femora. And yet there is in the Palestinian femora, as in the modern type, a tendency to produce a form which is triangular in section, base directed laterally, apex medially (Fig. 31 C, lower series A, B), while in the Neanderthal femora the outline is rather pear-shaped than triangular, the angles of the triangular section being rounded. In this respect the section of the Spy femur is more like the Skhūl type than is the Neanderthal femur (Fig. 31 C, lower series D).

The Hinder or Flexor Aspect of the Femur.

In Fig. 32 the hinder aspect of three femora is presented to bring out two contrasted forms. A represents the Neanderthal type of Europe, the type specimen, the left femur of Neanderthal man. Beside it (B) is a similar representation of the femur of an Australian male, a type of the slender form seen in modern natives. The one is powerful in its shaft and massive in its extremities; the other is the opposite. The one illustrates what may be called the 'cart-horse' type of the human femur, fashioned for slow and powerful movement. The other, the 'race-horse' type, is designed for speed rather than for power. There are differences, too, in anatomical conformation, in the shaft and in the proximal and distal extremities. Some of these have been mentioned, others remain to be discussed. There can be no doubt that the Skhūl femur approaches much more closely to the Australian than to the Neanderthal type. And yet in anatomical details Neanderthal characters can be recognized.

This view of the Neanderthal femur (Fig. 32 A) brings out a fact to which Dr. Hrdlička has drawn attention, that the shaft in Neanderthal man is bent so as to produce a medial convexity. The proximal part of the shaft runs downwards and inwards, while the distal part descends downwards and outwards. The shaft in the Australian native is almost straight; in the Skhūl femur the inward convexity is quite evident, and it is so in all the fossil Palestinian femora.

The drawings in Fig. 32 bring out the contrasted development of the linea aspera in the Neanderthal and in modern femora. In the Neanderthal femora the lateral lip of the linea aspera, which marks the origin of the vastus lateralis, makes a curved sweep down the hinder aspect of the shaft. The medial border caused by the vastus medialis muscle is but slightly raised; only in the middle third of the shaft do they approximate and form a low elevation. In the Australian femur both lips are well developed, meeting and running side by side throughout the central half of the shaft. It is also the case in Skhūl IV and V, only more so. Both lips are greatly developed and raised to form a stout ridge as in the tall Cromagnons. It was not so in all the Skhūl specimens; in Skhūl 7 (Fig. 32 D) the development is scarcely more than in the Neanderthal femur. This is also the case in the child's femur (Skhūl VIII). It was so in Tabūn I (Fig. 33) and also in the two other Tabūn specimens.

When the lips of the linea aspera are followed towards the knee, both the lateral and the medial are more sharply defined in Skhūl and the Australian than in the Neanderthal femur. When the lips are followed upwards, the lateral forms the inner or medial border of the gluteal ridge and as it approaches the base of the great trochanter may be raised into a ridge, often massive enough to form a trochanter tertius. The development of this trochanter, as of the gluteal impression and of the gluteal flange, is extremely variable in all the Palestinian femora. In no instance was there such a development of the trochanter as that seen in the Neanderthal bone (Fig. 32 A and C). Three of the Skhūl femora possess a moderately developed trochanter tertius. In all, the gluteal impression was more or less developed. The medial border of the linea aspera, as it ascends, passes in front of the trochanter minor. It is more sharply differentiated in modern femora than in the Neanderthal or Palestinian types.

The femur of the Tabūn woman being remarkable in so many ways, a drawing is given of the flexor or hinder surface of its proximal half (Fig. 33 A). Owing to the flat contour of the shaft, the posterior aspect appears extensive. The medial and lateral borders of the linea aspera are only slightly raised. They separate widely as they ascend, the one to pass to the extensor surface of the bone in front of the trochanter minor, the other ascending to the base of the trochanter major. The gluteal impression is deep and descends low on the shaft. As in the Neanderthal femur the great trochanter, seen from behind, seems to fade into the gluteal area without any sharp angle or demarcation.

The Distal End of the Femur.

The chief measurements are given in Table XVIII (p. 68). One of the most distinctive features of the European Neanderthal femur is the great width of the distal end, especially when we consider the restricted length of the bone. As may be seen from our table, the absolute width of this extremity in the Skhūl bones is only a few millimetres less than those of Spy and Neanderthal, yet it represents only about 17 per cent. of the total length,

whereas in Spy and Neanderthal the ratios are 21·9 and 20·6. The width ratio in the Australian femur is the same as the Skhūl bone. We have contrasted the femur (max. length 416 mm.) of the Tabūn woman with that of a Bushman (max. length 400 mm.); the absolute width is the same in both (70 mm.), the Bushman index is 17·5; the index in the Tabūn woman only 16·8. This is an important point in separating the Tabūn woman from the European Neanderthal type and in associating her with the Skhūl people. Amongst prehistoric femora only those of the tall Cromagnons described by Verneau surpass the Skhūl specimens in width of their distal ends. He records measurements of 90, 91, and 98 mm.

When we consider the antero-posterior diameters of the distal ends we find there is the same relative difference as in the width. What we have to describe is best understood if Fig. 34 is consulted. There are depicted views of the articular extremity of three specimens, the left femur of Skhūl IV, the left of an Australian male, and the left of the Neanderthal man. All were drawn with the bones orientated as already described. The projected height of the lateral condyle is represented by the vertical *C–D*; in Skhūl V this measures 75 mm., the same as in the Spy femur, but the ratio it forms to the femoral length in the Skhūl bone is 14·3 while it is 17·2 in the Spy femur. All the measurable Skhūl specimens fall into the same modern group, with the exception of the Tabūn woman. She reaches an almost Neanderthal ratio, but this may be due to a certain degree of displacement of the condyles.

The drawings in Fig. 34 bring out the relatively great forward projection of the lateral condyle in the Neanderthalian femur of Europe. In the modern femur (B) the medial condyle has taken on an increased height. In the contour of the articular end and in the relative development of the medial condyle, the Skhūl femur stands nearer to the modern than to the Neanderthal type. The patellar groove in Tabūn I is deep, but in its conformation the terminal end of the femur is of the Skhūl, not of the Neanderthal type.

We have seen that the patellae of the ancient Palestinians, as in their contemporaries in Europe, were very thick in their antero-posterior diameter. This is indicated in the drawings in Fig. 34 by the distance to which the lateral condyle projects above the patellar (trochlear) surface. In the Spy femur there is a deep fossa on the anterior face of the shaft, just above the patellar surface. This is especially deep because the articular area rises sharply above the level of the shaft. This is also the condition in the Neanderthal femur. The fossa in the Skhūl femora is the same shallow depression as is seen in the femur of modern man. Unfortunately, in Tabūn I the femur is injured at the site of the fossa.

We have recorded other measurements in Table XVIII (p. 68), but they throw no further light on the racial nature of the Palestinians beyond what we have already elicited. We also made measurements of the condyles and intercondylar space, but we found so much individual variation both in the fossil specimens we are describing and in those with which we compared them, that there seems no need to add further to our table of measurements.

Proximal End of Femur.

We have already dealt with two features of the proximal end of the Palestinian femur, namely, the angle which the neck forms with the shaft and the angle of torsion

(pp. 58–9). We shall now take up the consideration of one of the most characteristic features of the Neanderthal femur, the absolute and relative size of the head. As will be seen from the data we record in Table XIX (p. 69), the Palestinian femur differs altogether from the Neanderthal type of Europe and agrees with the modern form. The vertical diameter of the head of the Neanderthal femur is 54·5 mm., in Spy 55·5 mm., while the longest of the Skhūl femora has a head under 50 mm. in vertical diameter. When we consider the ratio of the diameter of the head to the maximum length of the femur we find that it is equivalent to 12 to 13 per cent. of the length in Neanderthal femora, while in the Palestinian bones it forms a smaller proportion, namely 9·6 to 10 per cent. The capitular index of Australian femora has a similar range. It will be noted that in this point, as in so many others, the femur of the Tabūn woman is modern—not Neanderthal.

Let us consider another diameter of the proximal end, namely, the distance of the most medial point of the head to the lateral border of the shaft, the measurement being made along the axis of the neck (Table XIX, p. 69). Three factors go to make up this measurement: the head, the neck, and the shaft. As is the case with the neck-shaft angle and the angle of torsion, so here there is a very great deal of individual variation. Yet the fact remains that, although in the absolute total the Skhūl femora almost rival the Neanderthal specimens recorded in our table, relatively the head and neck of the Skhūl femora are much less. In the Spy femur the head–neck length represents 26 per cent. of the maximum length of the femur; the ratio is 23·8 in the Neanderthal specimen. Among the Palestinian femora this index ranges from 21·2 to 22·3, the last mentioned index being that of the Tabūn woman. We cannot give the ratio for Skhūl IX, as only the proximal third of the bone is preserved. The highest capitulo-collar length measurement of the series was found in this specimen, namely 112 mm., and no doubt the ratio here would have been quite as high as in the Spy bone.

We made a full analysis of the elements making up the head–neck length, the proportion formed by the head, by the neck, and by the width of the shaft, and also the measurement of the true head–neck length defined by Martin (Femur 14), but met so much individual variation in both ancient and modern bones that we gave up their further consideration.

In Table XIX (p. 69) we record the vertical and antero-posterior diameters of the neck. In these, as in the diameter of the head and the length of the neck, the femora of the European Neanderthals exceeds absolutely and relatively those of the Palestinians; the Neanderthal femur had a neck which was longer and thicker than the Palestinian. These ancient people were modern in the size and proportions of the femoral neck.

We record measurements of the great trochanter (Table XIX, p. 69). They, too, are absolutely and relatively greatest in the Neanderthal femora. We record also in the same table two other noteworthy measurements, one which is indicative of the bi-trochanteric development, measured by the distance from the proximal border (mid-point) of the great trochanter to the apex (mid-point) of the trochanter minor. In this feature the Palestinian femora are Neanthropic, not Neanderthal.

The other measurement is that recorded in Table XIX, line 11 (p. 69). It really indicates the length of the neck measured in its posterior aspect. Here again we note the exceptional position of the woman, Tabūn I, and of Skhūl IX. They have long femoral necks, absolutely and relatively. Yet in relative neck length the Neanderthal type is even greater.

Certain racial differences in the proximal end of the femur are brought out better by drawings than by measurements. In Fig. 35 are depicted the proximal ends of three femora, Neanderthal, Skhūl IV, and an Australian male. They are drawn at right angles to the vertical plane (standard position of femur, p. 59). From this aspect the great trochanter of the Neanderthal femur appears excessively massive; in the Skhūl bone the trochanter has assumed the form and proportions seen in the Australian. A glance at these figures compels us to accept the conclusion already reached, namely, that in all its aspects the proximal end of the Palestinian femur is Neanthropic not Palaeoanthropic.

In many of their features the Krapina femora resemble the Skhūl type rather than the Neanderthal form. This is very well brought out by the photographs of a male and a female femur published by Kramberger (1906, Pl. XI, Figs. 1, 2).

We have seen that a characteristic feature of the Neanderthal femur is the width of its distal extremity. This is also true of the proximal extremity. The figures drawn in Fig. 36 represent the true width of the proximal end. In the Neanderthal specimen (Fig. 36 B) the width measures 101 mm., being 22·9 per cent. of the total length. In the Skhūl specimen the width is 94 mm., which is 19 per cent. of the total length, and the Australian measures 85 mm., this being 18 per cent. of the total length. Thus the Skhūl type approaches the modern and is removed from the Palaeoanthropic type.

There is an interesting feature of the great trochanter in the Skhūl femur which may be noted here; the upper border rises as it passes backwards. It falls as it passes backwards in the Neanderthal trochanter. In modern man it is usually almost horizontal (Fig. 26 A, B, C, *tip.*). A reference to Fig. 27 A will show the upper margin of the great trochanter in Tabūn I falling as it passes backwards, another Neanderthal feature of this woman. Also on the medial aspect of the great trochanter is the digital fossa, which in Tabūn I is wide and deep as in Neanderthal man (Fig. 33 A). This fossa in the Skhūl femur, although deep, is placed and shaped as in modern man (Fig. 32 A, B, C).

We represent an anterior or extensor aspect of a series of femora in Fig. 36 to bring out a point in the anatomy of Neanderthal man. Situated on the anterior aspect of the great trochanter of the gorilla is a prominent tubercle (Fig. 36 A, *tub.*), the trochanteric tubercle. It gives attachment to the transverse trochanteric fasciculus or band of the capsule of the hip-joint. In Neanderthal man this tuber is conjoined with the great trochanter and is very prominent (Fig. 36 B). In the Skhūl femur it has become less prominent and its connexion with the trochanter is more close. In the modern femur (Fig. 36 D) the development is still less; the anterior oblique (intertrochanteric) line has appeared and the tubercle forms a strong elevation in the upper part of this line. The intertrochanteric line in the Skhūl and Neanderthal, as in the gorilla femur, is very weakly developed.

We have passed in review observations relating to the characters of the Palestinian femur under four headings: (1) we have examined the bone as a whole; (2) we have dealt with the characters of the shaft; (3) with those of the distal end; and (4) with those of the proximal end. No matter which part or aspect we consider, the Palestinian femur is not of the Neanderthal type of Europe. It does show occasional leanings towards this type, but in nearly all its features it must be judged neanthropic, being of the femoral type found in modern races of mankind. These conclusions are reinforced when we consider a fifth heading: the patella and its relation to the knee-joint. Here, too, the one

complete Skhūl example is quite clearly Neanthropic in the greater number of its anatomical characters, not Neanderthal in type. The Tabūn woman in this, as in other features of the leg and thigh, is evidently akin to the Skhūl type, yet there are in her femur many points which make a nearer approach to the Neanderthal type than does any Skhūl femur.

Nor have we been able to discern any essential difference in trabecular structure, as revealed by X-ray examination of the proximal end of the femur, between the arrangement seen in the Tabūn, Skhūl, and modern femur (Pl. XXVII A, B, C).

Table XV. PATELLA

	Tabūn I	*Bush-man*	*Skhūl IV*		*Sikh*	*La Chapelle**	*Spy**	*Krapina**	*Cro-magnon**
	R	R	R	L	R				
Vert. diam. M 1 . .	36·0	35·0	49·0	47·0	42·0	39·0	46·3	42–4	49–51
Trans. diam. M 2 .	39·0	35·0	46·0	46·0	47·0	46·0	52·4	46–9	49–53
Ant.-post. diam. M 3 .	17·0	17·5	20·5	21·0	19·0	21·0	24·0	23–4	..
Vert. diam. art. facies M 4	(27·0)	30·5	34·0	34·0	29·0	..	..	..	..
Trans. diam. of med. facet M 5 . .	21·0	18·0	24·0	24·5	23·0	..	..	..	..
Trans. diam. of lat. facet M 6 . .	19·0	18·0	27·0	26·0	26·0	..	..	..	..

* Measurements of La Chapelle are from Boule (1911); Spy and Krapina from Kramberger (1906); Cromagnon from Verneau (1906).

Table XVI. FEMUR

	Tabūn I	*Bush-man*	*Skhūl IV*		*Skhūl V*	*Skhūl VI*	*Skhūl VII*	*Nean-derthal*	*Spy*	*Austra-lian*	*Sikh*
	R	R	R	L	R & L	L	R	R (cast)	R (cast)	L	R
Length:											
maximum M 1 . .	(416·0)	400·0	491·0	494·0	(518·0)	(477·0)	(438·0)	441·0	428·0	472·0	454·0
oblique M 2 . .	(415·0)	398·0	486·0	490·0	(515·0)	(475·0)	(435·0)	440·0	427·0	467·0	450·0
Trochanter length:											
maximum M 3 . .	(396·0)	396·0	475·0	477·0	(498·0)	(456·0)	(413·0)	433·0	..	459·0	445·0
oblique M 4 . .	(393·0)	390·0	462·0	465·0	(495·0)	(453·0)	..	425·0	..	443·0	430·0
Stature* . . .	1,537·5	1,565	1,736	1,741·7	1,787	1,709	1,580	1,642	1,617	1,700	1,666
Circum. at mid-pt. of shaft†	(81·0)	71·5	88·0	91·0	104·0	89·0	82·0	93·0	95·0	81·0	83·5
Length-thickness index .	19·3	17·8	17·9	18·5	20·5	18·7	18·8	21·2	22·2	17·3	18·5
Angle of neck to shaft M 29	(125·0°)	118·0°	121°	123°	133°	135°	..	120°	108°	126°	130°
Torsion of neck M 28 .	(17°)	17·5°	11°	25·5°	(12°)	18°	..	20·5°	21·5°	19°	10°
Condyle-shaft angle M 30	..	93·5°	99°	100°	96·5°	..	..	95°	98°	99°	111°

* Pearson's formulae: Male—813·06 + 1·88 (Femur); Female—728·44 + 1·945 (Femur).

† Taken at the mid-point of the shaft. The greatest posterior projection of the linea aspera is usually distal to the mid-point in the Palestinian femur. The figures therefore correspond to Martin's No. 8.

Table XVII A. FEMUR: THE DIAPHYSIS

	Tabūn I	*Bush-man*	*Skhūl IV*		*Skhūl V*		*Skhūl VI*		*Nean-derthal*	*Spy*	*Austra-lian*	*Sikh*
	L		R	L	R	L	R	L	R (cast)	R (cast)	L	R
Length of base, ant. arch of shaft* M 27	310·0	334·0	362·0	352·0	..	(385·0)	..	320·0	315·0	296·0	360·0	340·0
Subtense of arch†	6·0	10·0	10·0	8·5	..	18·0	..	20·0	15·5	14·0	12·5	10·0
Curvature index	1·9	3·0	2·7	2·4	..	4·7	..	6·2	4·9	4·6	3·4	2·9
Subtrochanteric diameters:												
ant.-post. M 10	23·0	20·0	25·0	25·0	32·0	32·0	26·0	25·0	28·0	27·0	24·0	26·0
transverse M 9	30·5	26·5	31·0	31·0	31·0	29·0	..	30·0	34·5	37·0	28·0	31·0
Platymeric index	75·4	76·2	80·6	80·6	103·2	110·3	..	83·3	81·1	73·0	85·7	83·8
Mid-shaft diameters:‡												
ant.-post.	23·2	23·0	33·2	33·5	38·5	(37·0)	32·0	31·0	31·0	30·0	29·5	29·0
transverse M 7*a*	27·0	23·0	26·0	26·0	27·0	27·0	27·0	26·0	29·0	30·0	23·0	24·0
Index	87·0	100·0	127·6	128·6	142·5	137·0	118·5	119·2	106·8	100·0	128·2	120·0
Supracondylar diameters:												
ant.-post. M 11	(22·0)	26·5	32·5	33·5	..	(36·0)	..	32·0	31·0	34·0	28·0	31·0
transverse M 12	(38·0)	32·0	42·0	44·0	..	(52·0)	..	36·0	39·0	42·0	33·0	36·0
Popliteal index	(60·0)	82·7	77·3	76·1	..	69·4	..	88·8	80·0	80·9	84·8	86·1

* Line *x–y* in Fig. 26. † Line *c–d* in Fig. 26.
‡ Taken at the mid-point of the diaphysis. The index is not the Index pilastricus of Martin.

Table XVII B. FEMUR: THE DIAPHYSIS

	Tabūn I	*Tabūn Ea*	*Skhūl III*	*Skhūl VII*	*Skhūl VIII (child)*	*Skhūl IX*	*Skhūl 7*	*Skhūl 8*	*Skhūl 9*	*Skhūl 10*
	R	R	L	R	R	L	L	L	L	L
Subtrochanteric diameters:										
ant.-post. M 10	..	25·0	..	(27·0)	15·0	27·0	..	..	..	..
transverse M 9	..	(32·0)	..	(29·0)	19·0	40·0	..	..	..	..
Platymeric index	..	78·1	..	93·1	78·9	67·3	..	..	..	..
Mid-shaft diameters:										
ant.-post.	22·0	26·0	35·5	27·5	16·0	..	32·0	29·0	23·5	..
transverse M 7*a*	24·0	28·0	31·0	26·0	17·0	..	27·0	24·0	25·0	..
Index	91·6	92·8	114·5	105·7	94·1	..	118·5	120·0	94·0	..
Supracondylar diameters:										
ant.-post. M 11	24·0	..	..	..	18·0	..	..	..	..	29·0
transverse M 12	32·0	..	..	..	22·0	..	..	..	..	34·0
Popliteal index	75·0	..	..	..	81·8	..	..	..	..	85·3

Table XVIII. FEMUR: THE DISTAL END

	Tabūn I	*Bush-man*	*Skhūl IV*		*Nean-derthal*	*Spy*	*Skhūl V*	*Skhūl VI*	*Skhūl VII*	*Austra-lian*	*Sikh*
	R	R	R	L	R (cast)	R (cast)	L	L	R	L	R
Width distal end M 21	(70·0)	70·0	85·0	(86·0)	91·0	94·0	(90·0)	(80·0)	(70·0)	82·0	84·0
Ratio width to max. length	16·8	17·5	17·3	17·4	20·6	21·9	17·3	16·7	15·9	17·3	18·5
Proj. length lat. condyle M 22*	(69·0)	58·0	70·0	71·0	75·0	74·0	(75·0)	(72·0)	..	68·0	62·0
Ratio height to max. length	16·5	14·5	14·2	14·3	17·0	17·2	14·3	15·1	..	14·4	13·6
Proj. height mid-trochlear point†	(47·0)	52·0	60·0	60·0	63·0	63·0	(66·0)	(57·0)	..	53·0	57·0
Proj. height medial condyle‡	(50·0)	54·0	65·0	65·0	66·0	66·0	(69·0)	(60·0)	..	58·0	60·0
Lower epiphysis length M 13(1)	(32·0)	25·0	34·0	33·0	32·0	34·0	(30·0)	(27·0)	(30–5)	28·0	29·0
Length lat. condyle M 23	(55·0)	57·0	70·0	71·0	73·0	73·0	..	71·0	(59·0)	62·0	62·0
Length medial condyle M 24	49·5	54·0	66·0	67·0	68·0	68·0	(65–70)	..	(50·0)	60·0	64·0
Length trochlear surface§	(31·0)	35·0	35·0	35·0	43·0	37·0	(42·0)	36·0	(29·0)	32·0	38·0

* Fig. 34, *C–D*. All projected measurements were made with the femur in the standard position described on p. 59.
† Fig. 34, *A–B*. ‡ Fig. 34, *E–F*.
§ Diameter in the sagittal plane taken from the middle of the upper cartilaginous border of the trochlear surface to the most distant point on the surface of the intercondylar notch.

Table XIX. FEMUR: THE PROXIMAL END

	Tabūn I	*Bushman*	*Skhūl IV*		*Skhūl V*	*Neanderthal*	*Spy*	*Australian*	*Skhūl VI*	*Skhūl IX*
	R	R	R	L	R	R (cast)	R (cast)	L	L	L
Diameters of head:										
vertical M 18	(40·0)	39·5	49·0	47·0	(50·0)	54·5	55·5	43·0	..	..
ant.-post. M 19	(43·0)	39·0	48·0	46·5	..	51·0	56·0	43·5	(44·0)	46·0
Index:										
vert. diam. max. length	9·6	9·8	10·0	9·4	9·6	12·3	12·9	9·1	..	..
Upper epiphysis length M 13	(93·0)	80·0	107·0	106·0	(111·0)	106·0	111·0	89·0	101·0	(112·0)
Ratio:										
upper epiphysis length to max. length of femur	22·3	20·1	21·7	21·6	21·4	23·8	26·0	19·0	21·2	..
Diameters of neck:										
vertical M 15	27·0	29·0	38·0	35·0	(35·0)	40·0	39·0	29·5	(30·0)	32·0
ant.-post. (least)	22·0	22·0	30·0	30·0	(33·0)	29·0	35·0	26·0	25·0	27·0
Ant.-post. diam. grt. trochanter at mid-pt. of its height	34·0	31·0	39·0	39·0	(35·0)	44·0	42·0	33·0	..	34·0
Great trochanter height*	40·0	38·0	48·0	47·0	49·0	49·0	..	39·0	..	(40·0)
Intertrochanteric distance†	(60·0)	62·0	74·0	76·0	(73·0)	83·0	(77·0)	65·0	..	(62·0)
Small trochanter-head length‡	48·0	36·0	53·0	50·0	(53·0)	49·0	55·0	46·0	..	63·0

* Distance from the mid-point of the upper border to the mid-point of the projecting lower border (with calipers).

† Distance from the mid-point of the upper border of the great trochanter to the apex (mid-point) of the lesser trochanter (with calipers).

‡ Distance from the apex of the lesser trochanter to the nearest point on the margin of the head (with calipers).



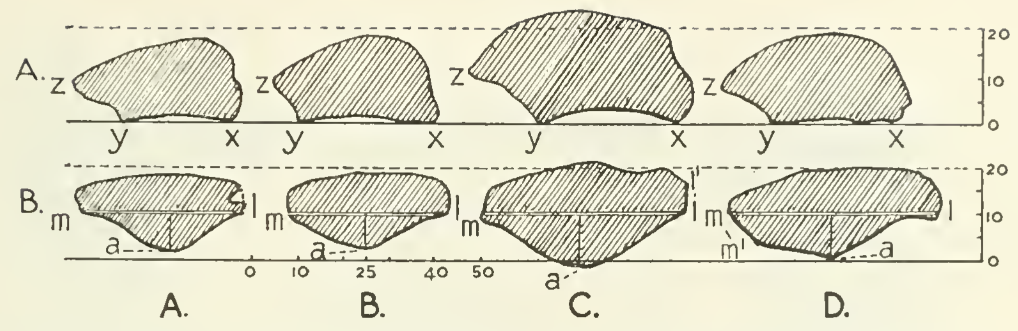


Fig. 25. The Patella. A, upper series. Sagittal sections made along the median ridge of the articular surface. B, lower series. Transverse sections made across the articular surface near its midpoint. A, Tabūn I, right; B, Bushman; C, Skhūl IV, right; D, Sikh. *x*, proximal margin of articular surface; *y*, distal margin of articular surface; *z*, beak for the attachment of tendon; *a*, apex of median vertical ridge; *l*, lateral margin of articular area; *m*, medial margin; *l–l′*, marginal area; *m–m′*, medial articular area. In the lower series the manner of measuring the height of the articular ridge is illustrated.

Fig. 26. The Femur, Lateral Aspect of the Right Bone. A, Neanderthal (cast); B, Skhūl IV; C, Australian (male); D, Skhūl VI. *P–P*, horizontal longitudinal plane drawn through the terminal points *x*, *y*; *O–O*, basal plane; *c–d*, height (subtense) of the curvature of the anterior border; *e–f*, maximum distance of the posterior aspect of the shaft above basal plane *O–O*; *tub.*, anterior tuberosity of great trochanter; *tip*, posterior-superior angle of great trochanter. For a full explanation of the method of orientation see p. 59.

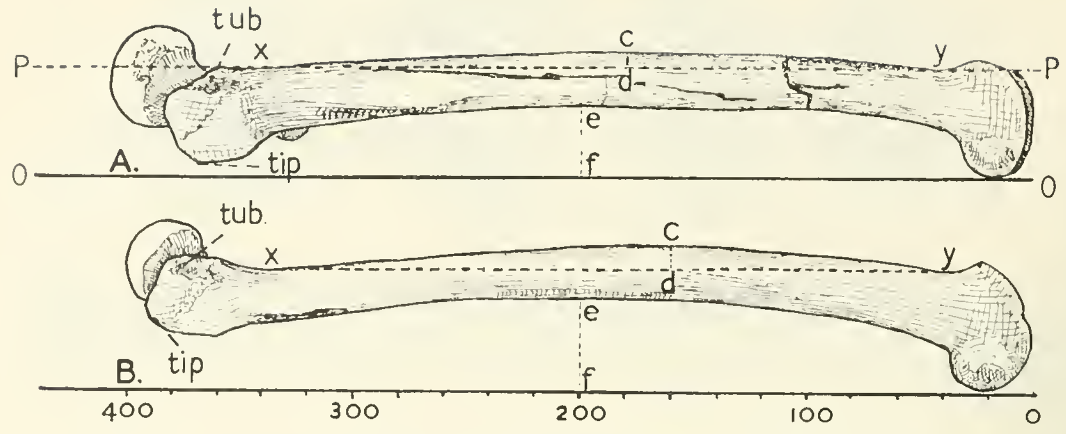


Fig. 27. The Femur, Lateral Aspect of the Right Bone. A, Tabūn I; B, Bushman (male). The letters have the same significance as in Fig. 26.

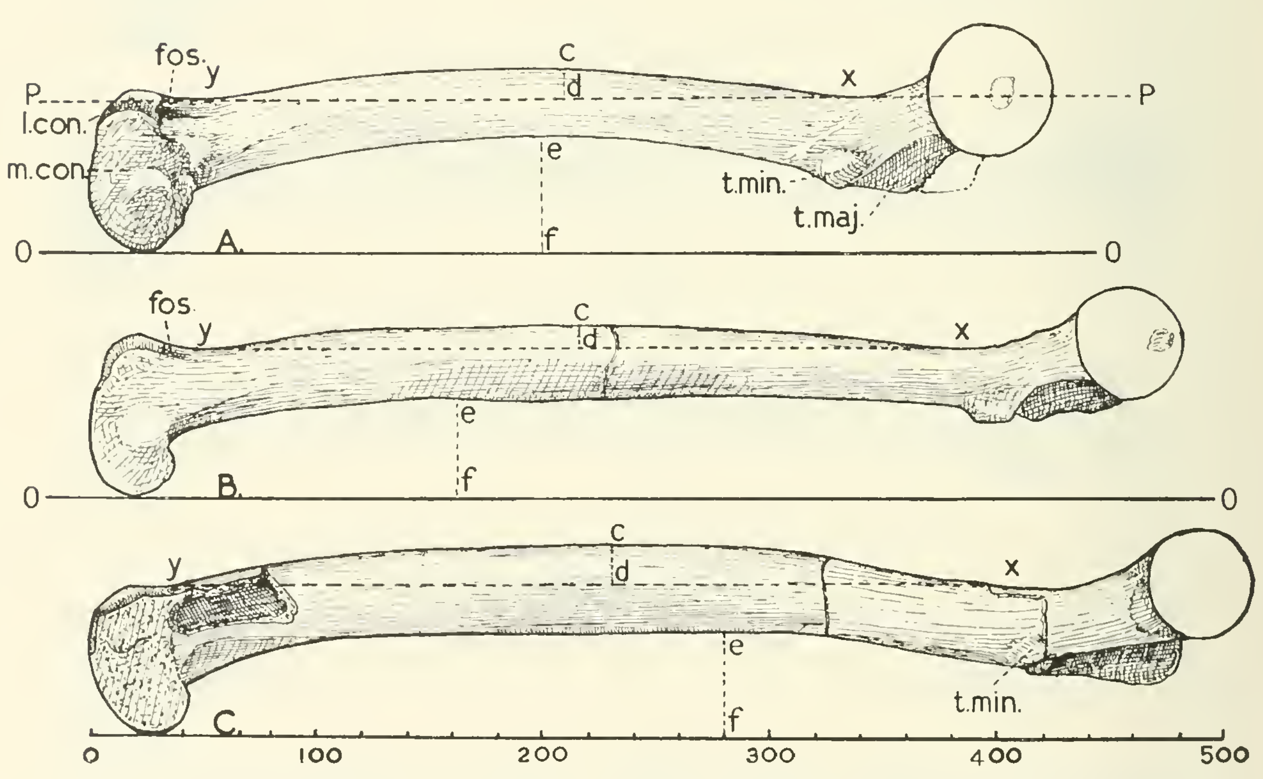


Fig. 28. The Femur, Right Medial Aspect. A, Spy I (cast); B, Skhūl IV; C, Skhūl V (reconstruction). In the latter the break just above the trochanter minor shows the proximal end of the right femur, the part distal to the fracture being of the left bone reversed. *l.con.*, lateral condyle; *m.con.*, medial condyle; *fos.*, supra-patellar fossa; *t.min.*, trochanter minor; *t.maj.*, trochanter major. Other letters as in Figs. 26, 27.

Fig. 29. *Above.* Medial Aspect of the Femoral Fragment. Tabūn E*a*. *Below.* A, B, C, transverse sections made at the points *A′*, *B′* (above the midpoint), and *C′* (subtrochanteric). D, Tabūn I, transverse section at the midpoint of this femoral fragment (p. 61). *g.f.*, gluteal flange; *g.i.*, gluteal impression; *m.f.*, medial femoral flange or ridge; *l.a.*, linea aspera; *t.min.*, trochanter minor; *v.m.*, vastus medialus.

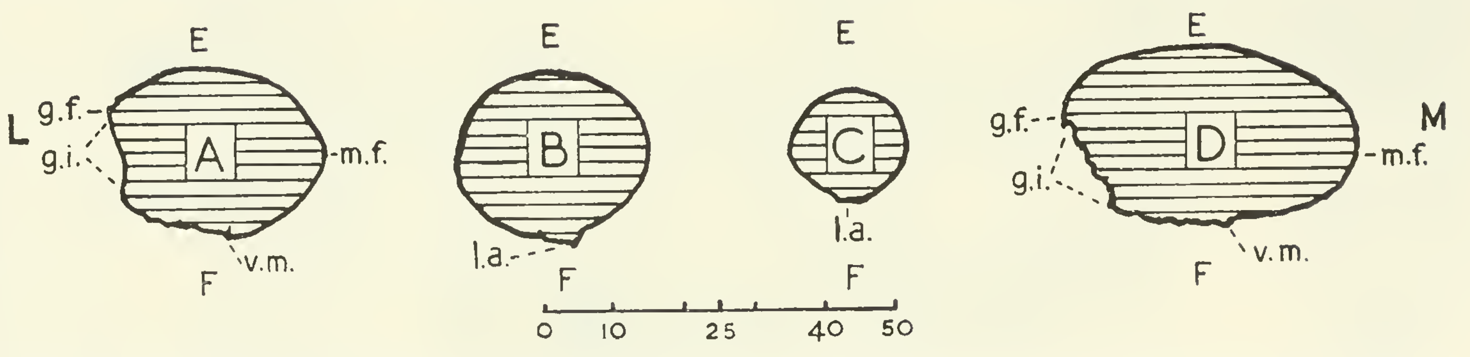


Fig. 30. Transverse Sections of the Femoral Shaft. A, Tabūn I, right, at the subtrochanteric point; B, Tabūn I, right, at midpoint of shaft; C, Skhūl VIII (child), right, at midpoint of shaft; D, Skhūl IX, left (reversed), at subtrochanteric point; *E*, extensor aspect; *F*, flexor aspect; *L*, lateral border; *M*, medial border; *g.f.*, gluteal flange or elevation; *g.i.*, gluteal impression; *v.m.*, line of attachment of vastus medialis; *m.f.*, medial femoral flange.

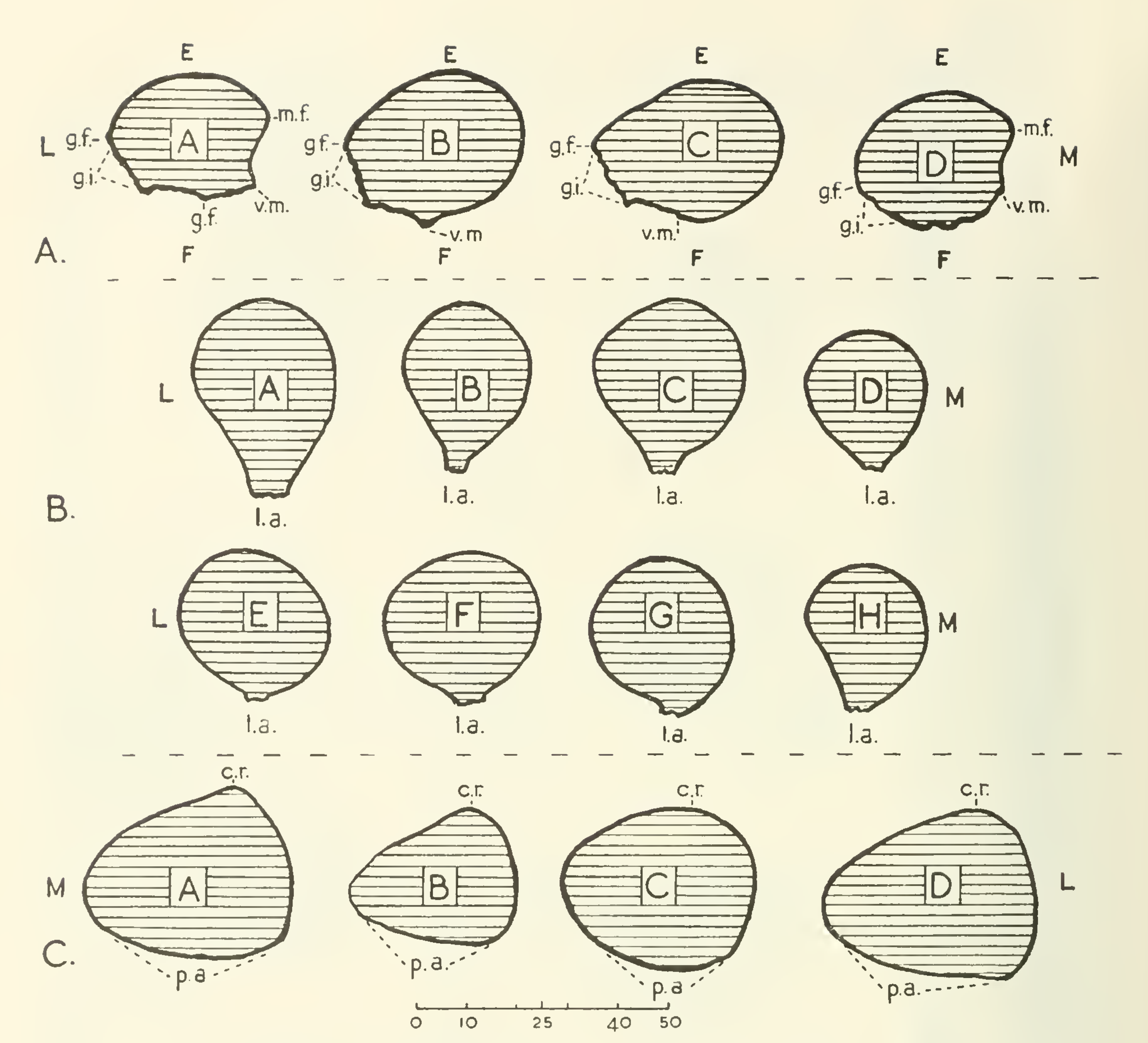


Fig. 31. Transverse Sections of the Femoral Shaft. A, upper series (at subtrochanteric level): A, Skhūl IV; B, Spy 1 (cast); C, Neanderthal (cast); D, English (Iron age male). B, middle series (at midpoint level): A, Skhūl V; B, Skhūl IV; C, Skhūl III; D, Australian (male); E, Spy 1 (cast); F, Neanderthal (cast); G, Skhūl 7; H, Sikh. C, lower series (40 mm. above the condyles): A, Skhūl IV; B, Australian (male); C, Neanderthal (cast); D, Spy I (cast). *E*, extensor aspect; *F*, flexor aspect; *L*, lateral aspect; *M*, medial aspect; *g.f.*, gluteal flange; *g.i.*, gluteal impression; *l.a.*, linea aspera; *m.f.*, medial flange; *q.f.*, quadratus flange; *v.m.*, line of attachment of vastus medialis; *c.r.*, lateral condylar ridge; *p.a.*, popliteal area.

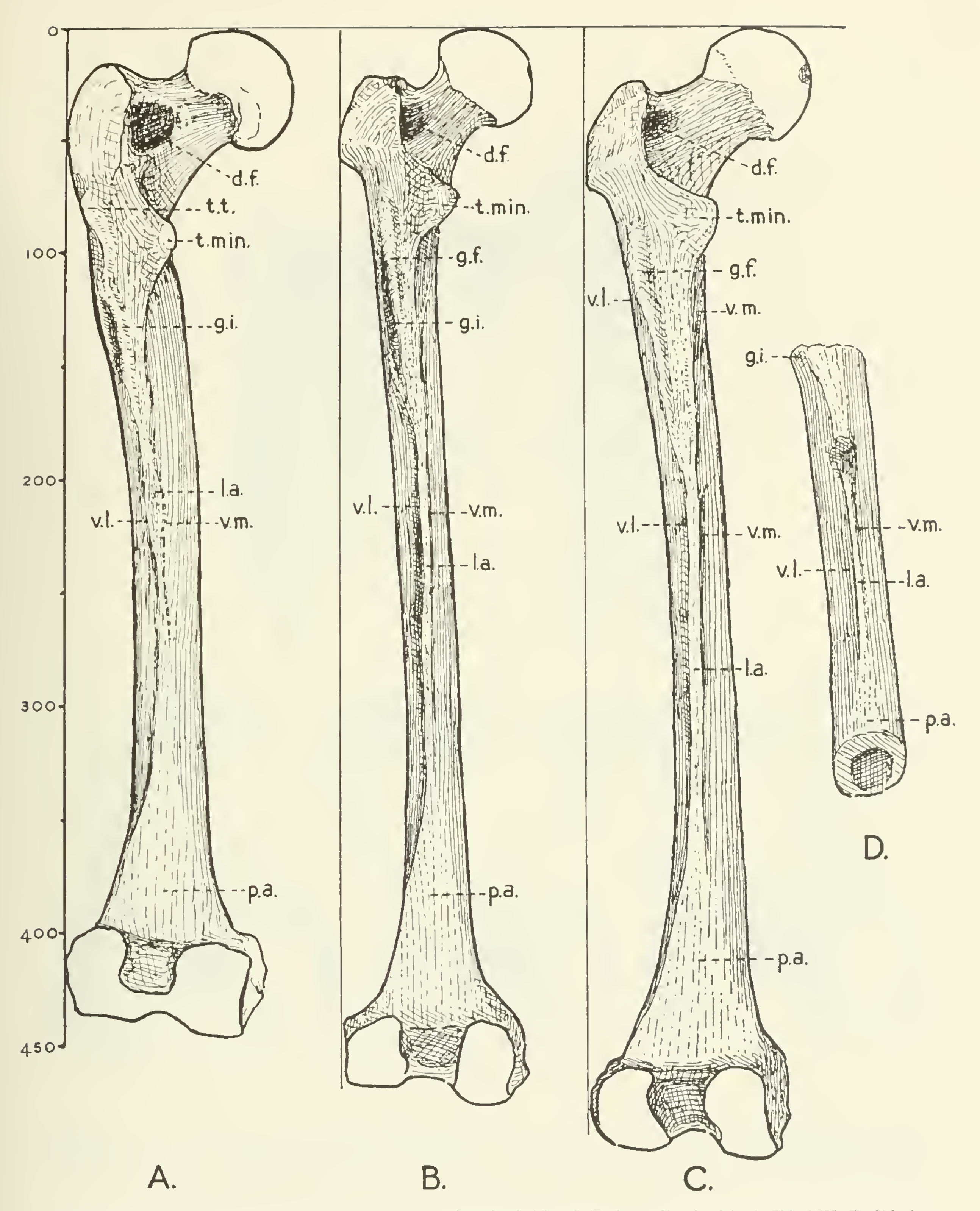


FIG. 32. THE FLEXOR ASPECT OF THE LEFT FEMUR. A, Neanderthal (cast); B, Australian (male); C, Skhūl IV; D, Skhūl 7 (fragmentary). *t.t.*, trochanter tertius; *g.f.*, gluteal flange; *g.i.*, gluteal impression; *v.l.*, lateral border of the linea aspera, for vastus lateralis; *v.m.*, medial border for attachment of vastus medialis; *t.min.*, trochanter minor; *p.a.*, popliteal area; *l.a.*, linea aspera; *d.f.*, digital fossa.

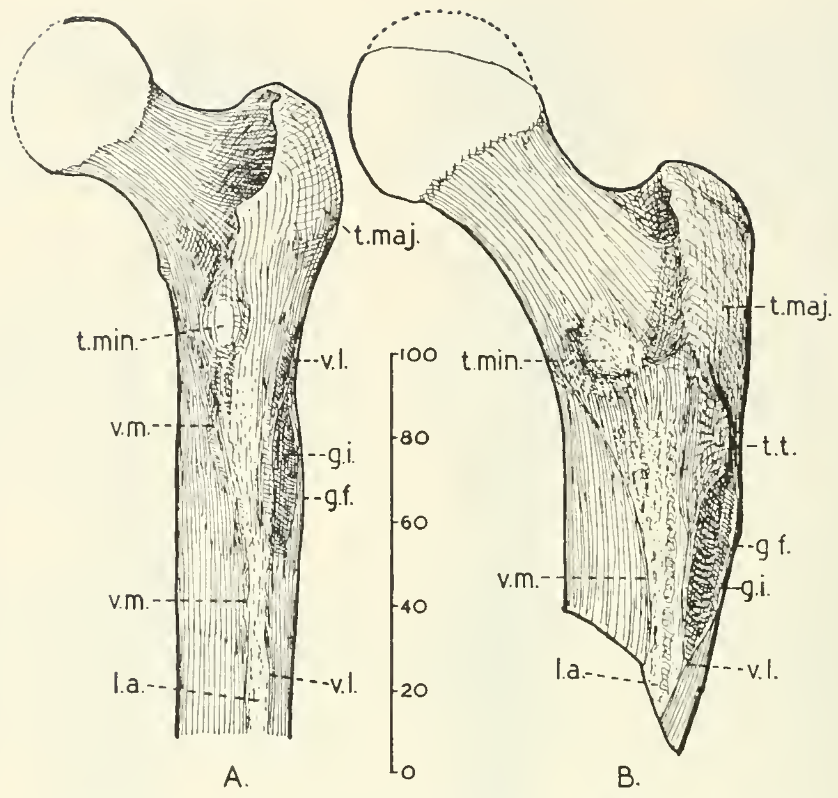


Fig. 33. Flexor Aspect of the Proximal End of the Femur. A, Tabūn I, right; B, Skhūl IX, left (reversed). *l.a.*, linea aspera; *v.m.*, medial border, for vastus medialis; *v.l.*, lateral border, for vastus lateralis; *g.i.*, gluteal impression; *g.f.*, gluteal flange; *t.min.*, trochanter minor; *t.maj.*, trochanter major.

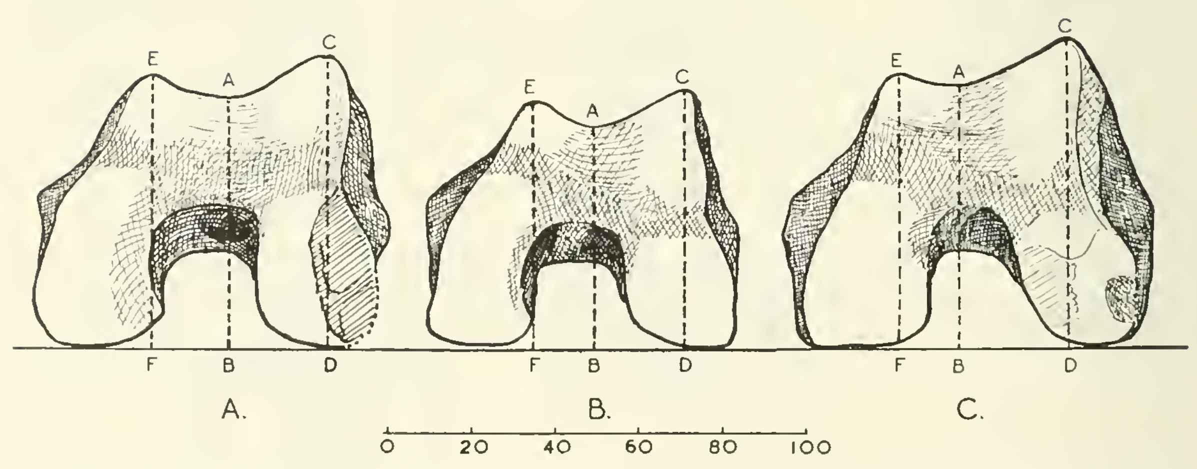


Fig. 34. Inferior Aspect of the Distal End of the Femur (in projection). A, Skhūl IV; B, Australian (male); C, Neanderthal (cast). All are left bones and were orientated in the standard position described in the text (cf. p. 59). The projected heights of the condyles and the trochlear surface are indicated by three vertical lines, *A–B*, *C–D*, *E–F*.

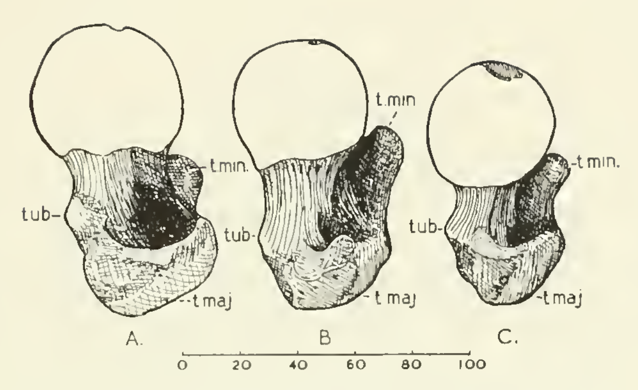


FIG. 35. SUPERIOR ASPECT OF THE PROXIMAL END OF THE FEMUR. The drawings are at right-angles to the plane described on p. 59. A, Neanderthal (cast); B, Skhūl IV; C, Australian (male). *tub.*, anterior tuberosity of the great trochanter; *t.maj.*, trochanter major; *t.min.*, trochanter minor.

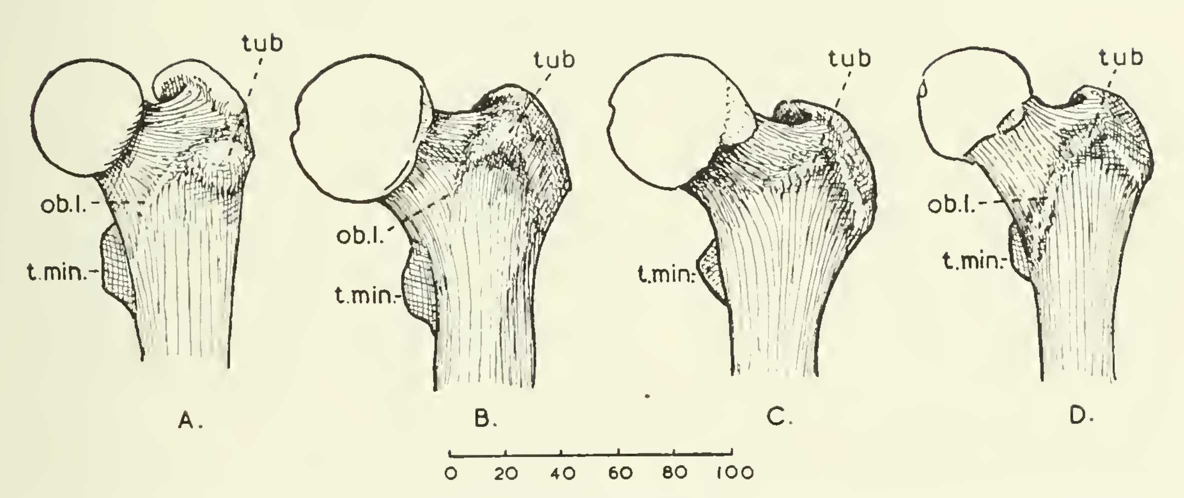


FIG. 36. ANTERIOR ASPECT OF THE PROXIMAL END OF THE LEFT FEMUR. A, Gorilla (showing the weak development of the trochanter); B, Neanderthal (cast); C, Skhūl IV; D, Australian (male). *tub*, anterior tuberosity of the great trochanter; *ob.l.*, anterior oblique or intertrochanteric line; *t.min.*, trochanter minor.



CHAPTER VI

THE PELVIS

THE OS COXAE (Pl. VIII; Figs. 37–61)

AS will be seen from the list which follows, we have a much more abundant representation of the hip-bone than has been found in any mid-Pleistocene site, yet the task of description and of drawing definite conclusions has been rendered difficult because of several circumstances. The first is the small number and fragmentary state of the fossil remains of the pelvis of Neanderthal man known to us. The chief specimen available for comparison is the left hip-bone of the original Neanderthal find. It lacks the pubis and part of the iliac crest. We had at our disposal an excellent cast of this specimen, from which we have ventured to make a new reconstruction of the Neanderthal pelvis —in the light of later discoveries. Boule had at his disposal parts of the right and left os coxae of La Chapelle man, from which he has made a noteworthy reconstruction (Boule, 1911, p. 144); indeed, his reconstruction is the most valuable of all that have been made. At Krapina nine pieces were found, and two of these, the more complete, have been figured by G. Kramberger (1906, Pl. X), but they are fragments. Klaatsch (1902) has given a description of the original Neanderthal specimen, while at a later date Dr. Hrdlička (1930) has examined the originals and published new details.

Another circumstance which has made our task difficult is the imperfect nature of many of our specimens; even those which are most complete are devoid of certain points needed for giving the full number of standard measurements listed in Martin's *Lehrbuch*. We trust that our photographs of the chief specimens and our accurate drawings will give readers the information which may be lacking in our text. Especially did we find it difficult to discover planes of orientation which would be applicable to pelvic fragments —planes which could be employed by other observers who wish to make comparisons with the specimens described in this monograph. Readers will meet with apparent discrepancies in our measurements, due to the use of more than one plane of orientation.

Before proceeding to describe our specimens in detail it may be helpful if we set down here the chief conclusions which our studies of the os coxae have led us to formulate. The first is that the anatomical details agree with those found in the pelvis of Neanthropic man, particularly the Cromagnon pelvis, rather than with those of the pelvis of Neanderthal man. Yet in the total assemblage of characters we meet with a larger proportion of Neanderthal features than are met with in any modern race of Neanthropic man. That is true of all the specimens from the Skhūl cave, but the woman (Tabūn I) from the Tabūn cave presents an altogether peculiar pelvic picture. Her pelvis differs not only from those of the Skhūl people but presents features, particularly in the conformation of her pubic bones, which have not been met before, either in living or in fossil man. The nearest parallel to her pubic conformation is to be found in the pelvis of the gorilla. In other respects her pelvis agrees with the Neanthropic rather than with the Neanderthal type, and yet Neanderthal features are present. We cannot think that her pelvic features are merely a manifestation of individual variation; they seem too sharply defined for

that. The pelvic features force upon us a need for hesitation in regarding this remarkable woman from the Tabūn cave as a mere variant of the Skhūl type.

List of Os coxae.

Skhūl I. See Chapter XX.

Skhūl IV. The right and left bones are almost complete (Pl. VIII). The areas for sacral attachment are much eroded, but sufficient details remain to indicate the shape and area of the sacral joint. No part of the base of the sacrum has been preserved, only the laminar area of the distal part of the bone (Sac. vert. 4, 5, with Coccyg. 1). The maximum width of the part representing the fourth sacral vertebra is 82 mm., rather greater than the corresponding vertebra of the Sikh, the base of which (Sac. vert. 1) measures 110 mm. By placing the right and left bones in normal articulation it can be seen that the sacral base of Skhūl IV was little, if any, narrower than in the Sikh. We can calculate the bicristal width of the pelvis of Skhūl IV with some degree of assurance. We estimate it to have been 280 mm. Martin gives the mean pelvic (bicristal) width for male Europeans as 279 mm., practically the same figure, but when we consider the stature of Skhūl IV, his body must be regarded as relatively narrow in the pelvic region, in this resembling the aboriginal type of Australia.

Skhūl V. This, the tallest of the Skhūl men (femur length 518 mm.) has a remarkably small pelvis. The greater part of the right os coxae has been preserved—only the pubic element being missing. The ilium is damaged in the region of the posterior iliac spines and on its anterior border (Fig. 41 D). As may be seen from Pl. VII, the head of the right femur is cemented so firmly within the acetabulum and is so 'earthy' in composition that we have made no attempt to dislodge it. The os coxae of Skhūl V is compared with the Neanderthal specimen in Fig. 41; about the same amount of hip-bone was preserved in each case.

It is impossible to make an exact estimate of the pelvic (bicristal) width of Skhūl V, but it was not more than 290 mm., and may have been 10 mm. less. This man, like Skhūl IV, was relatively narrow in the pelvic region. The proximal part of the sacrum with the right articular process and a little more than half of the spinous process of the first sacral segment is preserved, the latter extending beyond the mid-line and giving an estimated width of about 100 mm.

The vertical diameter of the acetabulum is 57 mm., a common measurement in the male pelvis of modern Europeans, whereas in the Neanderthal pelvis the corresponding acetabular diameter is 63 mm., and 66 mm. in the La Chapelle pelvis. In size of acetabulum, as in the femoral head, Skhūl man is modern, not Neanderthal.

Skhūl VI. See p. 6.

Skhūl VII. There are five fragments of this woman's pelvis, two of which formed part of the right os coxae. One of these carries the anterior part of the iliac crest, stopping short of the anterior superior iliac spine. The fragment measures 64 mm. in a dorso-ventral direction along the crest, 70 mm. in a cranio-caudal direction. The greater part of the fragment in its vertical extent is made up of the thickening or bar of bone which descends from the tubercle of the crest to the acetabulum. The thickness of the vertical iliac bar is 12 mm., and the tubercle of the crest was originally as strong and wide as in the ilium of Tabūn I. The width (thickness) of the latter is 20 mm. The second fragment

of the right os coxae of Skhūl VII represents part of the floor of the acetabular cavity with the lower (ischial) part of the acetabulum, and a splinter of the ischial tuberosity. Into the acetabulum are cemented two fragments of the head of the femur, one of which shows a widely 'gouged' groove, apparently the result of a wound in life or injury after death. This is noteworthy when we consider it in connexion with the remarkable acetabular wound in Skhūl IX. The thickness of the acetabular fragment, measured from the bottom of the groove between the acetabulum and the ischial tuberosity and the inner (pelvic) wall is 19 mm. In a male Australian pelvis the same measurement gave a thickness of 22 mm. The pelvis of Skhūl VII was certainly not massive and big.

A third fragment represents the anterior superior part of the left ilium—the region carrying the anterior superior spine and the iliac crest as far back as the tubercle. The centre of the tubercle lies 54 mm. behind the anterior superior spine, the same distance as in Tabūn I. The anterior part of the crest is rather thicker in Skhūl VII than in Tabūn I, the thickness midway between spine and crest being 13 mm. in Skhūl VII and only 10 mm. in Tabūn I.

The fourth and fifth pelvic fragments represent part of the base of the sacrum, too small and broken to give any certain indication of the width of the original bone. The fragments represent part of the body of the first sacral vertebra carrying the upper boundary of the first sacral foramen of the right side, and part of the body of the second sacral vertebra. The total length of the part formed by the bodies of the first and second vertebrae is 54 mm.; a corresponding measurement on the sacrum of a male Australian gave 47 mm. The thickness of the body of the first sacral vertebra (dorso-ventral diameter) near a point midway between the upper and lower borders is 21 mm.; the corresponding points in the Australian were 22 mm. apart.

Skhūl IX. We now come to one of the most important and surprising specimens found in the Skhūl cave. The pelvis in this case—the pelvis of a man of robust build—is represented by (1) about half of the left os coxae. The pubis is almost intact, while the ischium is complete save that the tuberosity has been damaged on its lateral aspect (Figs. 38, 57 A; Pls. VIII C, XXVIII A, B, C). The acetabular cavity is almost entire, but the ilium lacks the crest and the whole of the region which made contact with the sacrum. The proximal part of the femur is attached, being strongly flexed, with the head firmly cemented within the acetabular cavity. (2) The obturator foramen of the right side with its bounding framework of bone is also preserved. The bone on this side is stained a deep mahogany hue, while the bone of the left side is a light brown—almost straw coloured—save in the region of the symphysis which tends to assume a brown colour. The pubic and ischial elements of the left side are deformed by earth pressure, and appear to have been eroded on the surface, which is smooth and polished. The right acetabular cavity has gone and so has all the ilium. (3) There is, however, a dark brown fragment found a few inches from the pieces described above, which is part of the left ilium. This fragment which carries the hinder part of the iliac crest—the region of the posterior superior spine—has also on its medial surface the crumpled ilio-sacral area, while on its lateral aspect is part of the gluteal surface. The medial part of the posterior superior iliac spine is developed to an enormous extent, the total thickness of the crest at this point being 26 mm. Along the line of the crest this fragment measures 42 mm.; in a vertical direction 64 mm. Unfortunately the ilio-sacral surface is too deformed by earth

pressure to yield precise information. There is no point of contact between this fragment and the main part of the left os coxae. It must have been separated by an injury which will be described presently.

As we have seen, the femur of Skhūl IX is massive, its head having a diameter of 48 mm., while the vertical diameter of the acetabular brim is at least 56 mm. The first cuneiform bone of the foot is as big as that of Skhūl IV. The skull (Ch. XVIII) has unmistakable male characters. And yet the anatomical features of the pubic part of the pelvis are strangely like those of a female. Against this one must weigh the great size and massiveness of the preserved portions of the os coxae. Unfortunately, the pubic part of the pelvis of the Tabūn woman is entirely peculiar, and the only certain female coxal bones from the Skhūl cave (Skhūl VII) are so incomplete that we have no sure guide with respect to the sexual variability of the Palestinian pelvis. We are sure, however, that when we take into account all the evidence relating to all the remaining parts Skhūl IX was a male.

Our first knowledge of this individual was the partial uncovering of the skull during the course of excavation by one of the workmen. In the subsequent examination of the surrounding area of breccia the left os coxae with its femur was exposed. It lay with the visceral aspect of the bone directed downwards and inwards, the natural consequence of this individual having been buried on his right side. The head of the femur was exposed in section and a quadrilateral brown area was seen to extend well down into the centre of the section of the head. Later, in the course of preparing the left hip-bone of this man, we found that he had been the subject of a remarkable injury.

The brown area, as viewed superficially, proved to be a deep cavity running into and through both the head of the femur and the inner wall of the acetabulum, while the filling consisted of a brown matrix similar in colour to the breccia surrounding the rest of the bone but much less dense and compact. This was carefully removed, the surrounding cancellous bone being very friable. It was fully apparent that we had come upon the evidence of an extraordinary wound or injury inflicted upon this man.

The nature of the injury will be best understood by consulting Fig. 37 which shows an interior view of the pelvis. The wound here, sharply four-sided, measures 15 × 5 mm. In Fig. 38 is shown the point of entrance, viewed somewhat obliquely so that the full size of the perforation is not shown. Pl. VIII c shows the full size of the cavity; the entrance wound measures 17 × 11 mm., about the same width as at its entry to the pelvis but thicker, showing that the point of the implement or spear tapered in thickness but not in width.

We have been at some pains to obtain an impression of the cavity, and in Pl. XXVIII is shown the photograph of a cast which reveals the form of the implement. The instrument had penetrated the whole thickness of the head of the femur (48 mm.) and the floor of the acetabulum (5 mm.), a total of 53 mm. or 2 inches. By extending the lines forming the sides of the cast we estimate that the point of the weapon must have projected at least an inch within the pelvic basin.

When the pelvis is held up so that the light shines within the passage, it is seen to be quadrilateral in section with slightly rounded corners. The floor is smooth, the walls somewhat irregular as to surface, the crushed cancellous bone having been cemented by lime carbonate. The point of the weapon must have remained *in situ*. If the imple-

ment had been of bone, of ivory, or of stone it would not have perished and we should have had the head of the implement still *in situ*. It has disappeared and we infer that the spear or thrusting implement had a hard-wood point, which in the course of time perished.

When the instrument entered the pelvis, the hip-joint was locked, for the weapon penetrated both moving and fixed parts. The thigh was fixed in the position it occupied at the time the wound was inflicted, being strongly flexed on the belly, as when a person crouches or when lying on the side with the thighs flexed on the body. In this case the thigh was not only flexed but also somewhat rotated inwards at the hip-joint, so that the extensor surface of the left thigh looked outwards as well as upwards. The victim certainly presented his buttock (gluteal surface) to the weapon, whether he was cowering on his side with flexed limbs or crouching with head down. The weapon transfixed the gluteal muscles, entered the hip-joint, penetrated the head of the femur, splitting it, and splintering the ischium as the point sank within the pelvic cavity.

As may be seen from Fig. 37, the hinderpart of the brim of the true pelvis and the sacro-iliac region has been broken away, an injury sustained probably at the time of death. In the drawing (Fig. 37, *x*) there is a grooved impression where the ilium has been broken. This groove, we believe, marks the site of another thrust, probably made before the one which entered the hip-joint. So far as we know, this is the first evidence of the use of penetrating or thrusting wooden implements by men of the Mousterian age.

There are five fragments of the sacrum of Skhūl IX, but all are so imperfect that they throw very little light on the sacral dimensions. These fragments are: (1) the greater part of the body of the second sacral vertebra, which seems to have remained un-united with the body of the first. The depth (cranio-caudal diam.) of the second vertebra on its dorsal aspect is 17 mm. (2) There is part of the body of another sacral vertebra, possibly the first. (3) There was found in contact with the sacral surface of the fragment of the left ilium a part of the base of the sacrum; morphologically it represents the transverse process element (as distinct from the costal) of the first sacral vertebra. (4) Parts of the spines and the lamina of the second, third, and fourth sacral vertebrae—united into one irregular plate. (5) A plate of bone representing the terminal sacral vertebra (fifth); its original width must have been about 60 mm., the same width as in the sacrum of the Sikh. The spinous processes are broken off, save in the second vertebra.

Tabūn I. To save description, two diagrams (Figs. 39, 40) have been prepared to show the various parts of this remarkable pelvis. It was broken and crushed; the heads of both right and left femora were cemented so firmly within the acetabular cavities that their removal was found impracticable. In the diagram the femoral heads are omitted. The outlines on which these fragments have been placed were made from a female European (British) pelvis of ample proportions, the bi-iliac (maximum) width being 300 mm., the transverse diameter of the inlet of the true pelvis was 240 mm., the width taken between the supra-acetabular points[1] was 195 mm.—a large pelvis in every respect. The outlines of this British pelvis were made in the following way. The half of the pelvis to be drawn was placed in the pubo-acetabular plane, which passes from the uppermost point (medial margin) of the symphysis (Fig. 50, *a*) to the supra-acetabular

[1] This point is located midway between the lower margin of the anterior-inferior iliac spine and the adjacent margin of the acetabulum.

point already defined (Fig. 50, *b*). The brim (linea arcuata) of the true pelvis is kept level with this plane and the drawings are made at right-angles to the plane.

The left half of the Tabūn pelvis is the more fully represented (Fig. 39). The greater part of the ilium is present; only the posterior part of the crest and the corresponding area of the iliac plate are wanting. Part of the sacral surface is preserved but the bone has been crushed and deformed in this region. The pubis is represented from the symphysis to the acetabular cavity, which has been crushed. The ilio-pectineal eminence, forming the roof of the acetabulum, is preserved (Fig. 39, at *b*). We can estimate the total dimension from symphysis to supra-acetabular point. As regards length, the pubic element of the Tabūn woman is equal to those of the modern pelvis. We shall see, however, that length of pubis need not imply width of pelvis; the pubic rami may form a narrow angle with each other, the pubis thus adding to the length (d–v. diameter) as much as to the width of the pelvis (trans. diameter).

On the left side there is no part of the ischium, but this is preserved on the right side (Fig. 40). It and the basal (acetabular) part of the ilium form one piece, a mosaic of parts, yet not greatly distorted. In the diagram the ischial element has been displaced downwards so as to make it overlap the ischial element of the European pelvis. A large part of the pubis is preserved and it presents the same plate-like form which is to be seen in the corresponding element of the left side. There can be no thought of attributing this peculiar form of pubis to earth pressure; such pressure could not have produced identical effects on the two sides. On the right side the symphysial element of the pubis is represented by two fragments. In every part we meet with features which are unmistakably female.

Such, then, is the list of the material at our disposal for determining the characteristics of the Palestinian pelvis. For comparison, we have an excellent cast of the left os coxae of the Neanderthal skeleton. We have used the data provided by Boule relating to the La Chapelle skeleton and Verneau's measurements of the Cromagnon skeletons, with which the Palestinian pelves have much in common. In addition, we have employed for comparison other skeletons constantly mentioned in each section; the pelvis of a Sikh (male), stature 1,666 mm., femoral length 454 mm.; an Australian (male), stature 1,700 mm., femoral length 472 mm.

Proportions of the Os Coxae.

We propose to consider first three general characters of the Palestinian hip-bones: their height, their width, measured between the superior spines of the ilia, and the maximum pelvic width. The measurements of these dimensions are given in Table XX (p. 90), and the ratio of these measurements among themselves and to the stature, as represented by the maximum length of the femur. The relation of height to width is shown in Figs. 41, 42; of pelvic width to height of the os coxae, and of pelvic width to iliac width, in Figs. 44, 58, 59, 60. We may say at once that the relation of pelvic dimensions to femoral length differs altogether in the Palestinians from that which prevails among the European Neanderthalians. In actual height the hip bone of Neanderthal man (225 mm.) does not differ greatly from that of the Skhūl men (205, 218 mm.), but when we consider this measurement in relation to the stature, it is seen that the Skhūl men had relatively short hip-bones measuring 39·6 and 43·4 per cent. of the femoral

length, whereas in Neanderthal man the proportion is much greater, namely, 51 per cent. As may be seen from the data given in Table XX (p. 90), the relationship of coxal height to femoral length in the Palestinians agrees with that of modern races. In the case of La Chapelle man, Boule estimates the height to have been only 200 mm., which represents 46·5 per cent. of the femoral length.

The great width of the os coxae, as measured between the superior spines, both in its absolute amount and in its relation to coxal height, is a human character; the relatively greater the width, the more evolved the os coxae. If the reader will scan the table of measurements it will be seen that in absolute amounts and in relation to coxal height the Palestinians agree with modern man; nor in this matter are the European Neanderthalians peculiar, for in Neanderthal man the width is 73·3 per cent., while in La Chapelle man the coxal width is great—being 82 per cent. of the height. Indeed, the coxal width, considered in relationship to femoral length, is higher in European Neanderthalians than in any other race.

There is a difference between the Palestinian and Neanderthal os coxae which is seen on inspection of the profile views (Fig. 41), although this is not brought out by our measurements. The ilium in the Neanderthal pelvis reaches its highest point, anteriorly, in the region of the tubercle of the crest (Fig. 41 C, *x*), while in the Skhūl pelvis the highest point is farther back, in the area where the gluteus medius takes its origin from the iliac crest. This is the case in the modern pelvis (Fig. 41 A), but the character is not invariable in modern man, for in a Bushman's pelvis we found the same iliac profile as in Neanderthal man. It is remarkable that this Bushman pelvis presents other Neanderthalian features.

The other dimension dealt with in Table XX (p. 90) is the maximum width (bicristal) of the pelvis and the relationship of pelvic width to height and to femoral length. The pelvic height usually represents between 75 and 80 per cent. of the pelvic width; this is true of Skhūl IV, Cromagnon man, Neanderthal man, and modern man. There are exceptions; the pelvis of Skhūl V is remarkably low both absolutely and relatively. This is also true of Tabūn I, whereas in the Bushman the pelvic height represents 93·8 per cent. of the pelvic width. In La Chapelle man the pelvic height is estimated to have been 87 per cent. of the pelvic width, but this may be due to an under-estimate of the pelvic height. If we take femoral length as an index of stature then the Palestinians were narrow in the pelvic region of their bodies; in this matter they resemble the aborigines of Australia (Table XX, p. 90) and also the Cromagnons. On the other hand, the European Neanderthalians were absolutely and relatively wide in the region of the hips.

No bone of the human body has been modified more for posture and gait than has the os coxae. Hence in our examination of the Palestinian pelves we were on the lookout for features which might be regarded as transitional between the anthropoid os coxae, represented by that of the gorilla, and the fully established human pelvis. So that readers may follow our line of investigation, we have reproduced in Fig. 43 the right os coxae of an adult male gorilla, orientated and drawn exactly as in the preceding figures. The area for sacral articulation in the gorilla, carrying the auricular facet, occupies a long narrow strip of the hinder or dorsal margin of the bone, with the posterior superior and inferior iliac spines placed wide apart. In human evolution, the area for sacral attachment has been greatly extended in a dorsal direction, thus increasing the width of the ilium. It

has also been extended in a caudal direction, thus providing a dorsal border for the great sciatic notch or foramen. Now, as we shall see from the measurements to be given later, the backward and downward area for sacral attachment is as great, or even greater, in the Palestinians and also in the Neanderthals of Europe, as that in modern man. The adaptations for posture in the sacro-iliac region are just as complete in ancient races as in modern ones.

The second modification we would call attention to is the shortening and strengthening of that part of the ilium (let us call it the 'arcuate bar', as the linea arcuata defines its medial border; Figs. 41, 42, 43, *c*) which passes from the sacral articulation to the hip-joint, and transmits the weight of the trunk to the heads of the femora. The shortening and thickening of the arcuate bar is just as great (or even greater) in the Palestinians as in modern man. This is true of the European Neanderthalians and also of the Cro-magnons.

A third change relates to the ischium. If the condition in the gorilla (Fig. 42, *isch. t.*) be compared with that in man (Fig. 41 A) it will be seen that the ischium has undergone shortening, its tuberosities have ascended until they reach the level of the acetabulum, and at the same time the ischium has been bent backwards, diminishing the angle between it and the dorsal border of the ilium. These changes have proceeded to as great, or even greater, extent in the fossil beings we are dealing with as in modern man. We shall see that both in the European Neanderthals and in the Palestinians the ischial tuberosity has ascended to a greater degree than in modern races.

A fourth change is in the acetabulum. In man this cavity has become greatly increased in size and strength, the climax being reached in Neanderthal man. As we shall see, the acetabular cavity in the Palestinian pelvis, although deep, is relatively smaller than in modern man.

A fifth change relates to the pubis and symphysis. As will be seen from Fig. 43, the symphysis in the gorilla lies, when the pelvis is viewed in profile, immediately below the acetabulum. With the evolution of human posture the symphysis has been carried forward (in a ventral direction) and upwards towards the head. Now in the Skhūl male (IV) this change has been carried to a modern extent, but in one individual (Tabūn I) we shall find a state which has distinct anthropoid leanings.

A sixth change is important: on the crest of the human ilium, usually about one-third of the way along, if we begin our measurement at the anterior superior iliac spine, there is a well-marked thickening or 'tubercle of the crest' (Figs. 41, 42, *x*). The tubercle represents the upper end of a thickening or bar of bone which descends from the crest to the hip-joint. This bar—the 'vertical iliac bar'—represents a lever for the action of the muscles concerned in balancing the trunk laterally upon the thigh; the chief muscles which act on it are the external oblique of the abdominal wall and the gluteus medius and minimus, particularly the former. There is no trace of the bar in the anthropoid ilium; it is particularly well developed in all the Palestinian pelves. It is well developed in the Neanderthal ilium, in this specimen being placed remarkably near the anterior superior iliac spine. In Skhūl IV there is an attempt to duplicate the iliac bar; it is very strong in Skhūl IX.

A seventh change is also worthy of mention: the development of the anterior inferior iliac spine, which gives attachment to a muscle which plays an important part in human

progression, the rectus femoris. In the gorilla, this spine is represented by a rough flat area; in our Palestinians, as in the European Neanderthalians, the anterior inferior spine has assumed a massive size, is flattened from side to side, and bent laterally to a degree not found in modern pelves. Boule has drawn attention to the deep gutter or groove which is situated on the lateral aspect of this spine in the pelves of La Chapelle and Neanderthal. Its depth is due to the great outwards development of the upper margin of the acetabulum, a factor in producing a deep hip-joint. The supra-acetabular fossa and acetabular shelf are present in the Skhūl pelves but to a lesser degree—a degree met with in modern pelves.

Having outlined some of the principles which guided us in the examination of the pelvis of fossil man, and given the import of the conclusions we have reached, we now return to a description of the various elements which make up the os coxae. In the first section we considered the os coxae as a whole; we are now to inquire if the three elements, iliac, ischial, and pubic contribute to the formation of the bone in the same proportions as in the pelvis of modern man. We shall deal with the height of the ilium, the length of the ischium and of the pubis, the measurements being defined and given in Table XX (p. 90).

The human os coxae forms a series of levers which radiate out from the acetabulum of the hip-joint. These provide a basis on which the muscles of the thigh act as one steps forwards and the trunk is balanced upon the thigh. In Fig. 44 two of these levers are depicted, the upper vertical or iliac, and the lower vertical or ischial. In Table XX A (p. 90) the first two lines give the lengths of these levers in the Palestinian and other pelves. The lengths are measured from the margin of the inlet of the true pelvis, formed by the linea arcuata. These levers are absolutely and relatively longer in Neanderthal man than in the Palestinian or modern pelvis. Indeed, when compared with the modern pelvis the Palestinian has the shorter leverage, especially when we take total stature into account. It will be noticed that in Neanderthal man both levers are of equal length, as is the case in the Australian and in Skhūl IV (right side). On the other hand, Skhūl V has a particularly short iliac lever. It is only 15·8 per cent. of the femoral length as against 24·7 per cent. in Neanderthal man. In Skhūl IV and in the Australian this proportion is 21–2 per cent. In the Bushman and in the Sikh the ischial levers are relatively long. Thus the Palestinians agree with modern man in the absolute and relative lengths of the coxal levers, but, as may be seen in the sections reproduced in Fig. 44, the linea arcuata at the junction of the levers at the pelvic brim is less sharp than in the modern pelvis.

Further information concerning the relative and absolute sizes of the iliac, ischial, and pubic levers is given in Table XX A (p. 90) and in Fig. 45 (A, B, C).

There are two discrepancies in Table XX A which are due to deformity caused by earth pressure. It will be seen that the iliac lever on the left side of Skhūl IV is 9 mm. shorter than on the right side; the left ilium has been fractured and compressed. Similarly the ischial lever of Tabūn I is abnormally short. This is very apparent in the restoration attempted in Fig. 53. This is due to a compression of the acetabulum, which, as will be seen in the explanation to Table XX A, is included in all our measurements as part of the ischial lever. In the third line of Table XX A, the length of the lever formed by the 'iliac bar' is given, while in the fourth line is given the proportion which this

lever forms to the total height of the os coxae. Nothing definite emerges. In modern man the iliac lever is usually about 50 per cent. of the total coxal height, whereas in ancient man it is usually less than 50 per cent.

As regards the ischial element (Table XX A, lines 5, 6), the figures for the maximum ischial-supra-acetabular diameter and the proportion which this makes to the total coxal height bring out the absolute and relative predominance of the ischial element in the Neanderthalians of Europe. This is also emphasized by the drawings in Fig. 45. In the Neanderthal bone the ischium is 122 mm. long, representing 54·2 per cent. of the total coxal height. The corresponding figures for Skhūl IV (right) are 109 mm. forming a ratio of 50 per cent. of the total height. These approximate to the data given by modern pelves. As already mentioned, the measurement given for the Tabūn woman is abnormally short (43 per cent.).

When we come to deal with the pubic element we have to note the influence of sex. If we take stature into consideration the right pubis of Skhūl IV is remarkably stout and short, shorter than in the Sikh pelvis; its proportion, relative to the total coxal height, approximates to what prevails in pelves of modern males. In the Tabūn woman, and again also in Skhūl IX, the pubic element is remarkably long, 112 mm. in the first, 105 mm. in the second. In the large pelvis of a modern European woman the pubis was only 104 mm., representing 53 per cent. of the coxal height. In Skhūl IX this proportion was, we estimate, about 52–3 per cent. When we make allowance for the compression of the ischial element in Tabūn I, the pubic element must have been about 59–60 per cent. of the coxal height (Table XX, p. 90).

Thus, in our survey of the elements entering into the formation of the os coxae we have noted (1) a predominance of the ischial element in the European Neanderthalians; (2) a shortness of the pubic element in one Skhūl male (No. IV); (3) an elongation of this element in another Skhūl male (No. IX) and in the Tabūn woman. We shall return to certain peculiarities of the pubis in describing the pubic arch (p. 85).

In Table XX A, in the last line, we have given the vertical diameter of the acetabular cavity, including these measurements here because they will permit those who wish to do so to reduce our measurements to the central acetabular point recommended by Martin as a base from which measurements should be made. We have taken the vertical in preference to the antero-posterior diameter because it so happens that the former is the better preserved in our fossil specimens.

Acetabulum.

The acetabulum of Neanderthal man is wide and deep. The cast shows its vertical diameter to be 63 mm. and its depth (at the midpoint of a line joining the upper and lower margins) to be 32 mm. In La Chapelle the acetabulum has a diameter of 65 mm. In the tall Cromagnon men the acetabular diameter was 63 mm. in the Barma Grande male and 61 mm. in the male from the Grottes des Enfants, almost the same as in the much shorter Neanderthalians. In their acetabular diameters, as will be seen in our table of measurements, our Palestinians are modern, not Neanderthalian. In Skhūl IV (right), for example, the diameter of the brim is 59 mm. and the depth of the cavity 30 mm. This great development of the acetabular brim in the fossil specimens is seen in Fig. 45, B, C. Even in the very tall male (Skhūl V) the acetabulum has a diameter of

only 57 mm. In Skhūl IX the acetabulum has a vertical diameter of 56 mm., the same as in the pelvis of the Sikh (male). The depth of the acetabular cavity in the Sikh is 32 mm., not due to the height of the brim but to the depth of the floor of the acetabular fossa. In their acetabular dimensions the Palestinians were Neanthropic. So were the Krapina people; in one the vertical diameter was 54 mm., in another 57 mm. They correspond in their dimensions to the Palestinians.

Ilium.

Having made a survey of the os coxae as a whole, we now turn to a brief enumeration of the more striking features of the three elements, ilium, ischium, and pubis.

We were struck by the great curvature of the ilium in Skhūl IV (Fig. 46) whereby the dorsal part, carrying the sacro-iliac articulation, is bent in a lateral direction. The curvature of the crest is measured at *a* and *b* (Fig. 46), the vertical plane serving as a basis for measurement. The curvature at *a* has a depth of 31 mm.; at *b* of 10 mm. In the Sikh pelvis the depth at *a* is 37 mm., while at *b* it is only 2 mm. In the pelvis of a male Australian the anterior curvature had a depth of only 11 mm., while its posterior curvature was 15 mm. deep. In the Neanderthal pelvis the anterior curvature is 15 mm., the posterior only 5 mm. The bending or inflection of the plate of the ilium, represented in Fig. 46 A and B by stippled lines (*infl.*), is greater than that of the crest.

The inflection of the ilium is seen in the os coxae of the gorilla (Fig. 43). By this inflection the dorsal area, bearing the sacral articulation and attachment, is turned more or less into the antero-posterior plane. In the Neanderthal pelvis where the inflection is slight, the same result is obtained by a thickening of the sacro-iliac region, the sacral area being raised upon a platform of bone.

In Fig. 47 an attempt is made to restore the missing dorsal part of the ilium of Tabūn I and to estimate the degree of curvature. The short stature of the Tabūn woman and certain features of the ilium led us to think that light might be thrown on certain obscurities of her pelvis by comparing it with that of a Bushman. The posterior curvature is slight in the Bushman, but when we attempt to restore Tabūn I on similar lines we find a reconstruction is impossible. It becomes feasible only by presuming a considerable degree of curvature and of an extensive development of the dorsal area. The Tabūn iliac fragment is remarkably flat, but it is also deformed by pressure. Nevertheless, to explain the degree of deformity one has to assume that originally there had been a considerable degree of iliac inflection. In Skhūl V, although a part of the dorsal element of the ilium is missing, such parts as are preserved indicate that there was an absence of curvature, to about the same degree as in the Neanderthal bone. We have already mentioned the peculiar development of the anterior inferior iliac spine in the Palestinian ilium, and the depth of the supra-acetabular fossa, both being features which are shared with the Neanderthal but not with the modern ilium. The anterior border of the ilium, from the anterior superior spine to the supra-acetabular point, varies in length from 62 mm. in the Neanderthal pelvis to 60–5 mm. in the Skhūl specimens; it is only 51 mm. in the Tabūn pelvis. Modern pelves show a range of measurements similar to that met with in fossil specimens.

The tubercle of the crest is highly developed in the Skhūl ilia, being about 20 mm. in thickness. In the Neanderthal pelvis it is about 21 mm. thick; in the Tabūn specimen

it is also thick, 20 mm. In a male Australian the tubercle was 19 mm. thick; in the Sikh, only 16 mm. The iliac crest between the tubercle and the posterior superior spine is narrow in the Palestinians.

Area of sacro-iliac attachment.

In Fig. 41 a representation has been given of this area as seen in lateral profile. The area is separated from the basin or fossa of the ilium by the ligamentous line (*d*), while it is bounded on the opposite or dorsal side by the border between the posterior superior and posterior inferior spines. We shall speak of the distance between these borders as the width of the ligamentous area. The height of the area is represented by the distance from the lower border of the auricular impression (horizontal part) to the inner border of the super-adjacent part of the iliac crest. The area, in the Neanderthal ilium, measures 54 mm. (width) by 60 mm. (height). The thickness of the ilium at the auricular angle (anterior auricular point) is 32 mm. The corresponding measurements for Skhūl V are 56, 60, and 32 mm., practically the same as in the Neanderthal pelvis. The figures for Skhūl IV (left) are 55, 53, and 29 mm. respectively; for an Australian 47, 56, and 26 mm., and for a Sikh 55, 58, and 30 mm. Thus in the extent of the sacro-iliac attachment and in thickness of the bone in this area there is not much difference between ancient and modern pelves, but when we take stature into consideration the Neanderthal area and thickness are remarkable. As regards depth of iliac fossa the variation is much the same in ancient as in modern pelves, varying from 7 to 14 mm.

The Ischium and the Sciatic Notch.

A peculiar difference is brought out in Fig. 48 between the modern and the Neanderthal ischium. In the modern pelvis (Fig. 48 A) the groove for the internal obturator muscle (*obt. gr.*) lies above the ischial tuberosity and below the ischial spine. This is as in the gorilla (Fig. 43). In Neanderthal man (Fig. 48 B) the tuberosity has moved up towards the ischial spine and the groove for the muscle is situated on its medial and posterior border. In Skhūl IV (Fig. 48 C) the condition is intermediate. This relationship is variable, for in Skhūl V it is as in Neanderthal, La Chapelle, and the Krapina left fragment (female?). In Tabūn I and in the Krapina right fragment the condition is much as in Skhūl IV. An Australian and a Bushman pelvis also showed this intermediate condition.

The drawings in Fig. 48 also bring out a point in which the Skhūl pelvis tends to agree more with the modern form and differ from the Neanderthal. This is the forward position of the ischial tuberosity as regards the posterior border of the body of the ischium (Fig. 48, vertical *c–d*). In this feature the Skhūl pelves show a range from the Neanderthal to the modern condition.

We made a detailed series of measurements on the ischium and on the dimensions of the sciatic notch but have elicited no certain features which differentiate the Palestinian pelvis from the Neanderthal or modern. There is no doubt that the anterior border of the sciatic notch (the dorsal border of the ischium) tends to be long and straight in the Neanderthal pelvis, and this feature is also seen in the Palestinian pelvis, but it is also met with in modern pelves (i.e. Bushman). Measured from the top of the incisure to the lowest point of the ischial tuberosity, the Neanderthal os coxae gives a dimension of 119 mm., 7 mm. more than in Skhūl IV and 12 mm. more than in Skhūl V. In an Australian this

depth was 107 mm. and in a Sikh 112 mm. One measurement (Fig. 48 C, *x*) is precise and easily made: the width between the hinder border of the ischium and the adjacent margin of the acetabulum. It measures 40 mm. in the Neanderthal pelvis; 38 in Skhūl IV and V; 39 in the Sikh; 33 in an Australian, and only 30 mm. in Tabūn I. The dimension in Krapina (right) was 35 mm., in Krapina (left) 32 mm. The width of the sciatic notch is 52 mm. in Neanderthal, the same as in Skhūl IV. It measures 56 mm. in Skhūl V, 41 mm. in an Australian, 42 mm. in the Sikh (due to the high position of the ischial spine), and 55 mm. in the Bushman. Tabūn I is the only specimen showing an exceptional (female) measurement; we estimate the width of the notch as having been 60 mm. and shallow, only 25 mm. deep. In the others the depth ranges from 28 to 35 mm.

Pubis.

We have already dealt with the total length of the pubis and have considered this in relation to the height of the pelvis. In Table XXI (p. 91) we give another dimension, the distance from the inner margin of the acetabular cavity to the upper end of the symphysial margin of the pubis. These measurements bear out our previous statements, that this bone is particularly long in Skhūl IX and Tabūn I. Skhūl IV, however, exceeds in this respect the modern pelves with which we have compared it.

The antero-posterior sections of the pubis (made at the line *x–y*, shown in Figs. 50–4) and the measurements given in the second and third lines of Table XXI bring out certain remarkable features of the Palestinian pubis. The section of the ramus of Skhūl IV (Fig. 49 C) is particularly massive, more so than the sections of modern male pubes (Fig. 49 A, B). The section of Skhūl IX (F) is larger, particularly in the dorso-ventral direction, than is the corresponding section (E) of a large female European pelvis. The strangest of all are the sections of the right and left pubic elements of Tabūn I (G, H): they are flattened in a cranio-caudal direction, in this respect resembling the corresponding structure in the pelvis of the gorilla (Fig. 49 D; also Fig. 43).

In Figs. 50 and 51 the pubic region of Skhūl IX is compared with that of a large modern female pelvis. Both have been orientated on the same plane, the pubo-acetabular, represented by a double horizontal line in Figs. 50–4. The drawings are made at right-angles to this plane.

When the ancient and modern pubic regions are compared, the following points will be noted: (1) the length of the pubis as measured from the symphysis to the supra-acetabular point (*b*) is approximately the same (105, 104 mm.); (2) the obturator foramen is the larger and the true pelvis the deeper in the ancient specimen. In brief, there are no great or significant differences between the ancient and modern pelves in the views presented in Figs. 50, 51.

A comparison of the pelvis of Skhūl IX with Skhūl IV (Figs. 50, 52) will reveal many differences, but these are not attributable to sex. They are evidence of the great individual variability which confronts us in nearly all parts of the skeletons of these ancient Palestinians. The total pubic lengths are given in Table XX A (p. 90); the shorter pubic length in Table XXI (p. 91). The pubis of Skhūl IV is shorter, stouter, the obturator foramen smaller, and the true pelvis is shallower than is the case with Skhūl IX.

We now come to deal with the peculiar anatomical features revealed by the pelvis of the Tabūn woman, particularly by the pubic elements of the os coxae. In Fig. 53 all

the parts have been given their true anatomical connexions and drawn from the same point of view as in Figs. 50–2. It will be noted (1) that the Tabūn pubis is flattened and plate-like; (2) that it is extremely long; (3) that the true pelvis was very shallow, even when allowance is made for the shortening and apparently anomalous position of the ischium (Fig. 53). The obturator foramen has the appearance of being abnormally wide.

Drawn as we have grouped them, the pelvic fragments give an impression of erroneous reconstruction. The nature of the error is partly explained by a drawing of the pelvic parts of a gorilla (Fig. 54). In the anthropoid pelvis the pubes descend at an acute angle to meet at the symphysis, whereas in the human pelvis they are approximately at right-angles to the mid-vertical line of the symphysis. If, then, we arrange the pelvis of a gorilla on a horizontal pubo-acetabular plane (Fig. 54, *a–b*), we throw all the parts, iliac, ischial, and pubic, into very anomalous positions, not unlike the positions shown in Fig. 53. If we suppose that the pubic ramus was not only flattened and shaped as in the anthropoid pelvis but was placed obliquely, as in that pelvis, then we can account for features which at first sight seem so erroneous. We also obtain an explanation of the great length of the pubis in Tabūn I (Table XXI, p. 91, and Fig. 53).

In the gorilla the pubis, plate-like in section, becomes continuous with the obturator margin of the ischium as it approaches the acetabulum. The obturator foramen has a wide, plate-like margin in Tabūn I, as in the gorilla. In the latter the pubis takes no part in forming the articular cavity of the hip-joint, but this was not the case in the Tabūn pelvis (Fig. 53, *m*). The ischium in the Tabūn pelvis apparently occupied a position not unlike that seen in the pelvis of the gorilla.

In Fig. 55 B the parts of the left half of the Tabūn pelvis have been arranged in their natural positions and drawn directly from the front, as in Fig. 55 A. The pubic rami run more forwards than in the European woman, the result being that the supra-acetabular point and anterior inferior spine fall well within the 100 mm. vertical, whereas in the modern pelvis they fall just inside this mark, the cavity of the modern pelvis being truly the wider. In Fig. 55 B the head of the femur is shown still *in situ* in the acetabular cavity. In the specimen the femoral head has been driven inwards, compressing the acetabular end of the pubis; in our drawing the femoral head is shown in its true position, having been moved outwards to an extent of 10 mm.

Symphysis pubis.

We now move to a consideration of the symphysis pubis, illustrating what we have to say by the drawings shown in Fig. 56. This is a part of the anatomy of mid-Pleistocene humanity which has not been studied before because of the absence of material. The interpretation which we are to offer is based upon the classical researches of Professor Wingate Todd (1922). Measurements of the symphysis will be found in Table XXI (p. 91). A glance at these figures will show the strength of the Palestinian symphysis. It exceeds in height and thickness all those with which we have compared it.

Let us look first at the aspect presented by the articular surface of the symphysis of Skhūl IX. All the evidence is here which Todd regards as indicative of age—at least over 45 years of age. The great flat, smooth posterior articular area which Todd has named the 'platform' is exceedingly well developed (Fig. 56 C). So is the anterior elevated rough area, the 'rampart' (Fig. 56 C, *r*) formed out of the epiphysis of the joint; so, too

is a smooth area which ascends from the medial aspect of the sub-pubic arch. Above and in front of the rampart is a rough, ligamentous excavation. Below the symphysis is a roughened area or ridge for the sub-pubic ligament.

In the symphysis of Skhūl IV (Fig. 56 B) all of these areas are present, but the age-changes are less advanced and the joint is small, especially in its vertical diameter. In the Tabūn woman (Fig. 56 D) neither platform nor rampart is formed. There are rough parallel ridges for the attachment of cartilage, indicating that this woman was under 25 years of age. Lastly we have given a drawing of the Sikh's symphysis (Fig. 56 A) showing a younger stage in the development of the platform and rampart than is shown in Skhūl IV. There is nothing primitive or anthropoid in the symphysis of the Palestinian pubis, save its massiveness and strength.

Sub-pubic arch.

The character of the sub-pubic arch is the most striking of the various feminine features of the os coxae of Skhūl IX. Let us examine the sub-pubic arch of this specimen (Fig. 57 A). We have placed it in the antero-posterior axis which it would have assumed in the living body and we have orientated it so that the brim is in a horizontal position (the pubo-acetabular plane). A vertical line indicates the mid-symphysial plane; from this as a base we shall estimate the width of the arch. The point we shall select for measurement is the distal attachment of the crus of the penis in the male and of the clitoris in the female (Fig. 57, *c.a.*). In Fig. 57 A the measurement of the width of the arch is indicated at this point. It is 36 mm., so that the width of the complete arch at this point was about 72 mm. When we turn to the modern female pelvis (Fig. 57 B), we note many surprising differences. In the first place, the area for the attachment of the crus is enormously reduced, and the width of the arch, at the point chosen for measurement, is only 22 mm. or 44 mm. in the complete specimen. Even if we descend and take the measurement the same distance below the symphysis as in Fig. 56 A, the width is only 31 mm. Furthermore, the anterior edge of the pubic area of attachment in Skhūl IX is bevelled and thin, as in a female. When we turn to the condition presented by the sub-pubic arch of a definite male (Skhūl IV) we again meet with unexpected features. The width at the distal point of attachment of the crus penis is 31 mm. (total 62 mm.)—greater than in the modern female. The area of attachment is also shorter than it is in Skhūl IX, but the anterior bevelled edge of the pubic arch is thickened and tuberous, not sharp and everted as in Skhūl IX. If Skhūl IX is regarded as female, because of the great length of the pubis and the width of the sub-pubic arch, then we have also to suppose that the clitoris of the Skhūl women was developed to an extent not known in modern women. We shall throw some additional light on this problem when we proceed to the next section and examine the true pelvis from above.

One other remarkable feature of the sub-pubic region of the pelvis is the great size of the angle in the Palestinian specimens. The measurements are given in Table XXI (p. 91), where it will be observed that both Skhūl IX and Skhūl IV have values of about 80°: certainly it was not less than this in either specimen. The peculiar pubic conformation of the Tabūn woman, with the great length of the pubic ramus, make us sure that the angle was 100° or a little less, a measurement at the upper limit of the range of this angle in wide-hipped European women. The most common sub-pubic angle in European

men is about 60°, with exceptional individuals having an angle of 80° or above. Unfortunately there is no information known to us of this angle in Neanderthal man. The Palestinian males appear to have been altogether peculiar.

The pelvis from above.

In Fig. 58 views are given of the pelvis of Skhūl IV and of Skhūl IX, at right-angles to the plane used in the drawings of the pubic arch. The pelves are viewed on their upper or cranial aspect, showing the full extent of one side (left) of the inlet to the pelvis. Skhūl IV, orientated so and given a sacral width of 100 mm., has a total (bicristal) diameter of 280 mm.; that of Skhūl IX, with a slightly greater sacral width, 6 mm. more. The median sagittal plane of the pelvis is represented by a vertical line. The outline of Skhūl IX has been completed (stippling) by copying the outline from Skhūl IV. In both cases the anterior inferior iliac spines are depicted, and it will be observed that this spine is placed very far back in Skhūl IX, 25 mm. farther back than in Skhūl IV, owing to the length and obliquity of the pubic ramus. It will be seen that the pelvic brim of Skhūl IX is destroyed behind the level of the inferior spine, damaged by one of the injuries described on pp. 74–5. The point of entry of the instrument into the pelvic cavity is marked *x* in Fig. 58 A. We have therefore to reconstruct the brim of the pelvis in this area, which has been done by following the contour of neighbouring parts. The auricular point (*a.p.*) is 58 mm. distant from the mid-line in Skhūl IX, 50 mm. in Skhūl IV, giving an estimated sacral width of 116 mm. in the first and 100 mm. in the second. As will be seen from the measurements given in Table XXII (p. 91), these are quite within the range of modern measurements. The maximum width of the inlet of Skhūl IX must have been at least 124 mm. and in Skhūl IV 114 mm. These measurements are of the order met with in the pelvis of Australian aborigines; they are below the mean for Europeans. We may take the distance between the inter-auricular line and the symphysis pubis (Fig. 58) as a measure of the conjugate diameter of the inlet. This conjugate is 94 mm. in Skhūl IV and 98 mm. in Skhūl IX, which are similar to measurements made on modern male pelves (Table XXII, line 3). There is one anomalous feature of Skhūl IX: the anterior inferior spine lies very close to the auricular point; the distance in Skhūl IV is 71 mm., but in Skhūl IX it is only 62 mm. We shall return to this point in considering the pelvis of Tabūn I.

How does the Palestinian pelvis compare with that of the tall man of Cromagnon from the Grottes des Enfants? In Fig. 59 we reproduce a tracing of Verneau's drawing of this Cromagnon pelvis. It is 294 mm. wide, 14 mm. wider than the pelvis of Skhūl IV. It will be observed to be fuller in the posterior region of the pelvic basin, but in the contour of the pubic wall and in the shape of the inlet the two come very near to each other. The Cromagnon is somewhat the wider (137 mm. as against 114 mm.). The resemblances between the male pelves from Mount Carmel and Mentone are many and close, much more so than between the former and the Neanderthal type.

We now return to a fuller consideration of the pelvis of Tabūn I. In Fig. 60 B we give a reconstruction viewed at right-angles to the pelvic brim and therefore comparable to the drawings given in Figs. 58 and 59. By the side of it (Fig. 60 A) is given the outline of the inlet of a large pelvis of a modern European woman. Three measurements, forming a triangle, are indicated by stippled lines. They unite three points, the auricular (p. 82),

the supra-acetabular (p. 75), and the supra-symphysial. The absolute and relative lengths of these lines bring out features of the true pelvis: the measurements are given in Tables XX, line 7, XXII, lines 3, 4, 5. There is one of these measurements which requires consideration: that joining the auricular point (*a.p.*) to the supra-acetabular (*b*). This is normal in the Fig. 60 A, whereas in the Tabūn pelvis it is only 62 mm., exactly the same as in Skhūl IX (Fig. 58 A). It is quite clear that in both these pelves the pubic wall of the true pelvis is very long and set obliquely. At first we suspected an error in our reconstruction, but in the case of the Tabūn pelvis all parts are present and a mistake may be eliminated. If we compare the ratio which this line (*a.p.–b*) holds to (*a–b*), as has been done in Table XXII, line 6, we find that in the Tabūn pelvis the iliac width is only 59·8 per cent. of the length of the pubic wall. In Skhūl IX it is 59 per cent., and it will be noted that the Cromagnon relationships are similar. In all the other pelves the range is from 70 to 89 per cent.

The width and conjugate diameters of the Tabūn inlet are compared with those of a European female in Fig. 60, the Palestinian excelling in all save the iliac width; in the Tabūn pelvis it is 67 mm., as against 73 mm. in the European. The Tabūn inlet is very long and of moderate width; in these measurements it is primitive, more so than any other Palestinian pelvis. The nearest approach to it is made by Skhūl IX.

We have one other series of comparisons to make before we finish this section devoted to the pelvis. How does the Neanderthal pelvis compare with the Palestinian and the modern when viewed from above? In Fig. 61 the pelvis of a Sikh, of Skhūl IV, and of the Neanderthal man are represented side by side. All have been orientated in the erect position and drawn at right-angles to this plane from above. In this reconstruction we have increased the bi-auricular width of Skhūl IV to 114 mm., 14 mm. above that shown in Fig. 58. It is possible that in Fig. 58 and in our Table of measurements we have under-estimated the width in Skhūl IV. As represented in Fig. 61, the maximum width is nearly the same in all three, and the contour of the iliac crest is very similar in the modern and the Palestinian pelves. The posterior part of the Neanderthal pelvis has been reconstructed and may not be true, but it is most unlikely that it was folded in as are the other two. Nor do the transverse diameters of the inlet differ greatly. The Neanderthal was probably the narrower, especially in the sacral region. We have given a theoretical reconstruction of the pubic ramus of the Neanderthal specimen. Resemblances rather than differences impress one when the modern and the Palestinian pelves are studied from the aspect represented in Fig. 61, strengthening our conclusion that the resemblances of the Palestinian are to the modern rather than to the Neanderthal pelvis.

THE SACRUM

The representation of the hinder wall of the pelvis in the Mount Carmel people is incomplete. At the beginning of this chapter we have noted all those parts which have been preserved. No trace of the sacrum remained with the skeleton of Tabūn I. The material at our disposal comes from Skhūl IV, V, and VII, the sacral fragment of Skhūl I (child) being described in Chapter XX.

The extremely robust bony masses in which the iliac crests terminate dorsally in the pelvis of Skhūl IV bespeak a massive sacro-iliac musculature, although the conformation of the pelvis in this individual and also in Skhūl V indicates a sacrum of moderate width,

probably 100–105 mm. A drawing of the basal part of the sacrum of Skhūl V is given in Fig. 71 B, viewed from behind. In the same figure (Fig. 71 A) is shown the corresponding parts of the sacro-iliac region of a Sikh's pelvis. Another view of the sacral fragment from Skhūl V is shown in Fig. 62 B. The cranial end of the vertebral canal is comparatively large in both Skhūl men; its width in Skhūl V is 27 mm., its height (d–v diameter), 14·5 mm.; in Skhūl IV the width is 31 mm., the height 18 mm. The canal in the La Chapelle sacrum is 26 mm. wide and 20 mm. high. The width in the sacrum of the Sikh is 29 mm., the height 16 mm., but it has, as in most modern sacra, a triangular outline.

The articular surfaces of the upper sacral processes in Skhūl V have a vertical diameter of 18·3 mm., a dorso-ventral diameter of 16·5 mm., these dimensions being almost the same as in the sacrum of the La Chapelle specimen. The articular surfaces are concave in a dorso-ventral direction in Skhūl V, whereas in the La Chapelle sacrum, as is so common in modern specimens, they are almost flat. The La Chapelle sacrum is wider in all its parts than is Skhūl V. The bi-articular width, taken between the extreme points of the articular surfaces, is 52 mm.; in the La Chapelle example the width is 3–4 mm. more. The width of the body of the first sacral vertebra we estimate to have been just over 40 mm.; in La Chapelle it was 4–6 mm. wider. The maximum width of the La Chapelle sacrum was 106 mm.; we must suppose that in Skhūl V this measurement was somewhat less. The photograph which Boule gives of the basal aspect of the La Chapelle sacrum presents many details which we find reproduced in the sacral fragment of Skhūl V. The lamina of the first sacral vertebra has its lower border, bounding the first sacral canal, sharply defined and its concave dorsal surface merges into the concavity of the articular area of the upper process. The first sacral spinous process is represented by a mere thickening of the dorsal lamina. In Skhūl IV the spinous process is 16 mm. long and sharply defined (Fig. 62 C). This is a point of little taxonomic value, for the first sacral spine is amongst the most variable structures in human anatomy.

Although we can give no accurate estimate of the width of the lateral sacral mass in the Skhūl sacra, we can measure the development of this mass in a dorso-ventral direction. The plane along which this measurement was taken is indicated by the broken line (*d–d*) in Fig. 62. This diameter measures 36 mm. in Skhūl V, an amount equal to the same measurement in the La Chapelle sacrum. This diameter is 35 mm. in the sacrum of a Sikh, 29 mm. in an Australian male, and 28 mm. in a Bushman sacrum (Fig. 62 A). The lateral mass was not lacking in dorso-ventral strength in ancient man.

Only small fragments of the base of the sacrum of Skhūl IV were recovered (Fig. 62 C). One of these is remarkable: it is a plate of bone representing the greater part of the surface of the area of the body of the first sacral segment. Its dorso-ventral diameter is 32 mm. In the Sikh this diameter measures 31 mm. and its width is 51 mm. Our reconstruction gives a width measurement of 52 mm. (Fig. 62 C). The same cordiform shape is reproduced in the body of the first sacral vertebra as that which we meet with in the lumbar vertebrae (Fig. 73 B).

The only large fragment of the sacrum at our disposal is shown in Fig. 63 B. It is from Skhūl IV and represents the dorsal part of vertebrae 4 and 5, with a small part of 3. The latter is represented by the spine and by the part of its lateral mass which bounds the opening of the third sacral canal along its cranial margin. The pelvic or ventral aspect of the fragment has been completely eroded, and the lower and lateral parts of

Sacral 5 have been broken away and lost. The extreme lateral parts, representing the costal elements (Fig. 63 B, *m*) of Sacral 4 and of Sacral 3, have been lost too, and there is no part of the articulation with the os coxae remaining.

How modern in its conformation is this fragment may be gathered from its close resemblance to the corresponding parts of the sacrum of the Sikh. The lowest vertebra (S 5) must have been considerably wider than that of the Sikh, the width of this latter measuring 68 mm., but in Skhūl IV it must have been over 80 mm. In its width Sacral 4 must have been proportionately about the same. It is 88 mm. in the Sikh and we estimate that it was rather more in Skhūl IV (90 mm.). On the other hand, the third pair of sacral foramina are set much closer together in Skhūl IV than in the Sikh (Fig. 63 *e*). In both the vertebral canal is open distal to the third spinous process, being bounded laterally by the rudimentary arches of Sacral 4 and Sacral 5. The transverse elements of the lateral mass in both Sacral 4 and Sacral 5 are apparent, and of about the same degree of prominence and the same distance from the mid-dorsal line.

When we take into consideration the size of the fragments of the base of the sacrum and the width of the fragment just described, it seems probable that in its maximum width the sacrum of Skhūl IV fell little, if at all, short of the width in the Sikh's bone, which is 116 mm.

Summary.

Our examination of the pelves and the pelvic fragments from Mount Carmel has led us to form the following opinions:

1. That in the size and structure of the pelvis the ancient Palestinians were much nearer to the Cromagnon (Neanthropic) people than to the Neanderthal (Palaeoanthropic) people of Europe.

2. The pelvic fragments found at Krapina are Palestinian in type rather than Neanderthal.

3. Yet we do not exclude the Palestinian and Krapina people from the Neanderthal (Palaeoanthropic) group because of pelvic characters, for they still possess certain features which are Neanderthal and not Neanthropic.

4. The adaptations to the erect posture were just as complete and perfect in the Palestinians as in the modern races of mankind.

5. We have come to the conclusion that the pelvic characters of the Tabūn woman are such as to compel us to reconsider her position—whether she may not be representative of a race more ancient than the Skhūl people—or an imported foreigner. The anatomical evidence favours the idea that she is of a more ancient strain than that from Skhūl cave.

6. In the pelvis of Skhūl IX we have met with a mixture of sexual characters, some—such as the length of the pubic ramus and the capacity of the true pelvis—which favour the female sex, while others, such as the area on the sub-pubic arch for attachment of the external genital organ, favours a male diagnosis. Taking other features into account, those of skull, femur, and foot, we think it impossible to regard this individual other than as a male.

Table XX. OS COXAE

	Skhūl IV		*Skhūl V*	*Tabūn I*	*Skhūl IX*	*Neanderthal*	*Sikh*	*Australian*	*Bushman*	*Cro-magnon**
	R	L	R	R & L	L	L (cast)				
Max. height M 1	218·0	211·0	(205·0)	(188·0)	(194·0)	225·0	209·0	203·0	185·0	235·0
Bispinous width of ilium M 12	(158·0)	165·0	(170·0)	(143·0)	..	(165·0)	162·0	154·0	124·0	173·0
Ratio:										
max. height—bispinous width	72·4	78·2	82·9	76·0	..	73·3	77·4	75·8	67·0	73·6
max. height—max. femoral length	44·1	42·7	39·6	45·2	..	51·0	46·0	43·0	46·2	44·6
bispinous width—max. femoral length	32·0	33·4	33·0	34·3	..	37·4	35·7	32·6	30·1	32·8
Maximum width of pelvis M 2	(280·0)		(290·0)	(260·0)	(285·0)	(282·0)	264·0	260·0	196·0	294·0
Ratio:										
max. height—max. pelvic width	77·7	75·3	70·6	72·8	..	78·0	79·1	78·0	93·8	79·8
max. pelvic width—max. femoral length	57·0	56·5	56·0	62·4	..	63·9	59·8	55·1	49·0	55·9

* Male from the Grottes des Enfants.

TABLE XX A.* OS COXAE

	Skhūl IV		*Skhūl V*	*Skhūl IX*	*Tabūn I*	*Neanderthal*	*Australian*	*Sikh*	*Bushman*	*British (female)*
	R	L	R	L	R & L	L (cast)				
Height of ilium M 10	(106·0)	110·0	(94·0)	..	(103·0)	116·0	102·0	101·0	84·0	102·0
Height of ischium†	105·0	103·0	(114·0)	(113·0)	101·0	116·0	102·0	107·0	107·0	109·0
Height of iliac bar‡	103·0	(94·0)	82·0	..	(97·0)	109·0	100·0	106·0	94·0	101·0
Ratio: height of iliac bar to total height of os coxae	47·2	44·5	40·0	..	51·6	48·4	49·2	50·7	50·8	48·0
Max. ischio-supra-acetabular diam.§	109·0	110·0	(108·0)	(114·0)	81·0	122·0	102·0	108·0	94·0	112·0
Ratio: ischio-supra-acetabular diam. to total height os coxae	50·0	52·1	52·6	..	43·0	54·2	50·2	51·6	50·0	53·3
Medio-lateral pubic length‖	94·0	(90·0)	..	105·0	112·0	..	86·0	97·0	79·0	104·0
Ratio: medio-lateral pubic length to total height os coxae	43·1	42·6	..	52·5	59·5	..	42·3	46·4	43·0	53·0
Greatest diam. of acetabular brim M 22	59·0	58·0	57·0	56·0	(48·0)	63·0	52·0	56·0	47·0	52·0

* We regret having been unable to adopt those measurements which Martin recommends to be made from the centre point of the acetabulum. This was due to the imperfect state of the acetabulum in some of our specimens and in others to the impossibility of freeing the head of the femur from the cavity, but we are also of the opinion that the measurements we have taken are preferable to those recommended by Martin.

† Taken from the point where the maximum transverse diameter of the pelvis intersects the arcuate line, to deepest point of the ischial tuberosity.

‡ Taken from the iliac crest above the tubercle to the nearest point on the acetabular rim (by calipers).

§ Taken from the most distant point of the ischial tuberosity to the supra-acetabular point (defined on p. 75).

‖ The length of pubis from the supra-acetabular point to the upper symphysial point.

Table XXI. OS COXAE (PUBIS)

	Skhūl IV		*Skhūl IX*	*Tabūn I*		*Australian*	*Sikh*	*Bushman*
	R	L	L	R	L	R	R	R
Acetabulo-symphysial diam.*	72·0	(69·0)	83·0	(80·0)	(81·0)	59·0	66·0	51·0
Pubic ramus:								
dorso-ventral width†	27·0	25·0	19·0	15·0	17·0	18·0	20·0	20·0
depth, pelvic‡ aspect	17·0	18·0	17·0	6·5	7·0	15·0	16·0	15·0
Symphysis:								
cranio-caudal diam. M 18	44·0	44·0	48·0	(40·0)	(39·0)	37·0	37·0	37·0
dorso-ventral diam.	21·0	22·0	23·0	(15·0)	(16·0)	19·0	19·0	14·0
Obturator foramen:								
length M 20	(48·0)	(45·0)	52·0	(41·0)	..	41·0	52·0	44·0
width M 21	(36·0)	(38·0)	39·0	..	..	31·0	36·0	34·0
Obturator-symphysial diam.§	28·0	28·0	34·0	29·0	..	17·0	25·0	17·0
Sub-pubic angle M 33	80–5°		(80°)	(100°)		58°	59°	55°

* Distance measured by calipers from the supra-symphysial point to the most medial point on the margin of the acetabulum.

† The width measured from the dorsal (pelvic) to the ventral margin where the pubis crosses the groove for the obturator nerve (Figs. 50, 53 *x–y*).

‡ The depth taken at the same point as the preceding measurement parallel to the inner wall of the ramus.

§ The distance measured from the most medial point of the medial margin of the obturator foramen to the lower end of the symphysial surface. It is equivalent to about half the inter-obturator breadth.

Table XXII. OS COXAE

	Skhūl IV	*Skhūl IX*	*Tabun I*	*British (female)*	*Australian*	*Sikh*	*Bushman*	*Cro-magnon*
	R	L	L					
Bi-auricular width*	100·0	116·0	124·0	130·0	90·0	112·0	95·0	124·0
Max. transverse diam. of inlet†	114·0	124·0	130·0	152·0	107·0	128·0	102·0	137·0
Estimated conjugate diam. of pelvic inlet‡	94·0	98·0	115·0	100·0	98·0	94·0	94·0	77·0
Oblique conjugate width of pelvic inlet§	(112·0)	(118·0)	(132·0)	118·0	120·0	121·0	108·0	100·0
Iliac width‖	(71·0)	(62·0)	(67·0)	73·0	77·0	75·0	68·0	58·0
Ratio: iliac width to length of pubic wall¶	75·5	59·0	59·8	70·1	89·5	77·3	86·0	54·7

* The width (estimated for the fossil specimens) between the auricular points, giving a measure of the width of the sacrum. The auricular point is situated at the anterior end of the auricular impression for the sacrum, where the arcuate line impinges on the auricular area.

† Measurements of the fossil specimens are estimates.

‡ Measured from a line joining the auricular points to the posterior (dorsal) aspect of the symphysis, in the sagittal plane of the inlet.

§ The distance from the auricular point to the supra-symphysial point.

‖ Width of the ilium from the auricular point to the supra-acetabular point.

¶ Ratio of the medio-lateral diameter of the pubis (Table XX) to the iliac width. (Grottes des Enfants male, medio-lateral pubic length, 106 mm.).



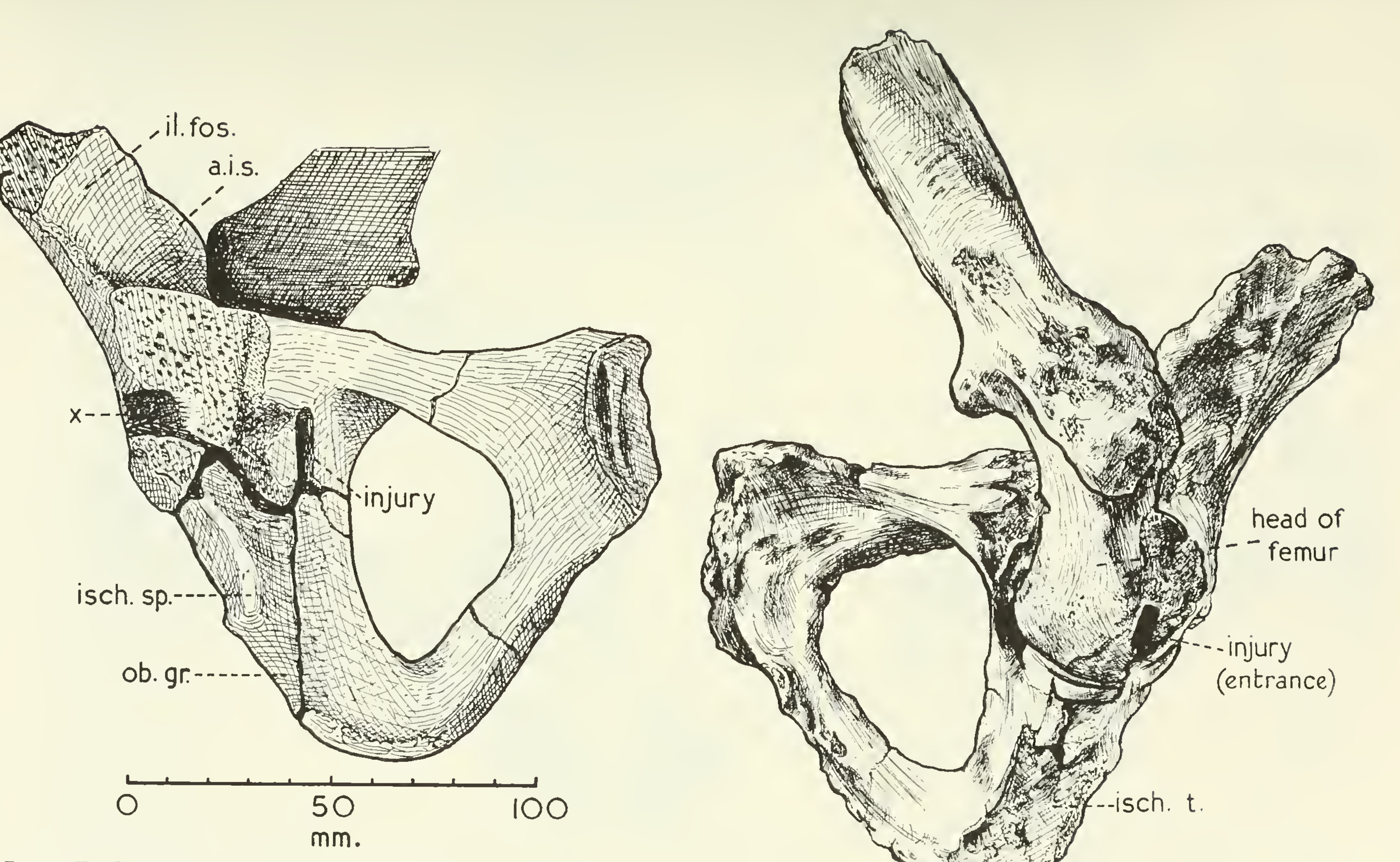


FIG. 37. THE INTERIOR OF THE LEFT OS COXAE OF SKHŪL IX. The drawing is made at right angles to the pubic plane (p. 75). The wound (injury) at its point of entry into the pelvic cavity is shown and the splintering of the ischium caused by the thrust of the implement. At the point *x* is a groove, evidently representing one side of another penetrating wound. This broke away the brim of the pelvis. *isch. sp.*, ischial spine; *ob. gr.*, obturator groove; *il. fos.*, iliac fossa; *a.i.s.*, anterior inferior spine.

FIG. 38. THE EXTERNAL ASPECT OF THE LEFT HIP-JOINT OF SKHŪL IX, showing the entrance of the wound and the fractured state of the femoral head. The femoral fragment is strongly flexed. *isch. t.*, ischial tuberosity (broken).

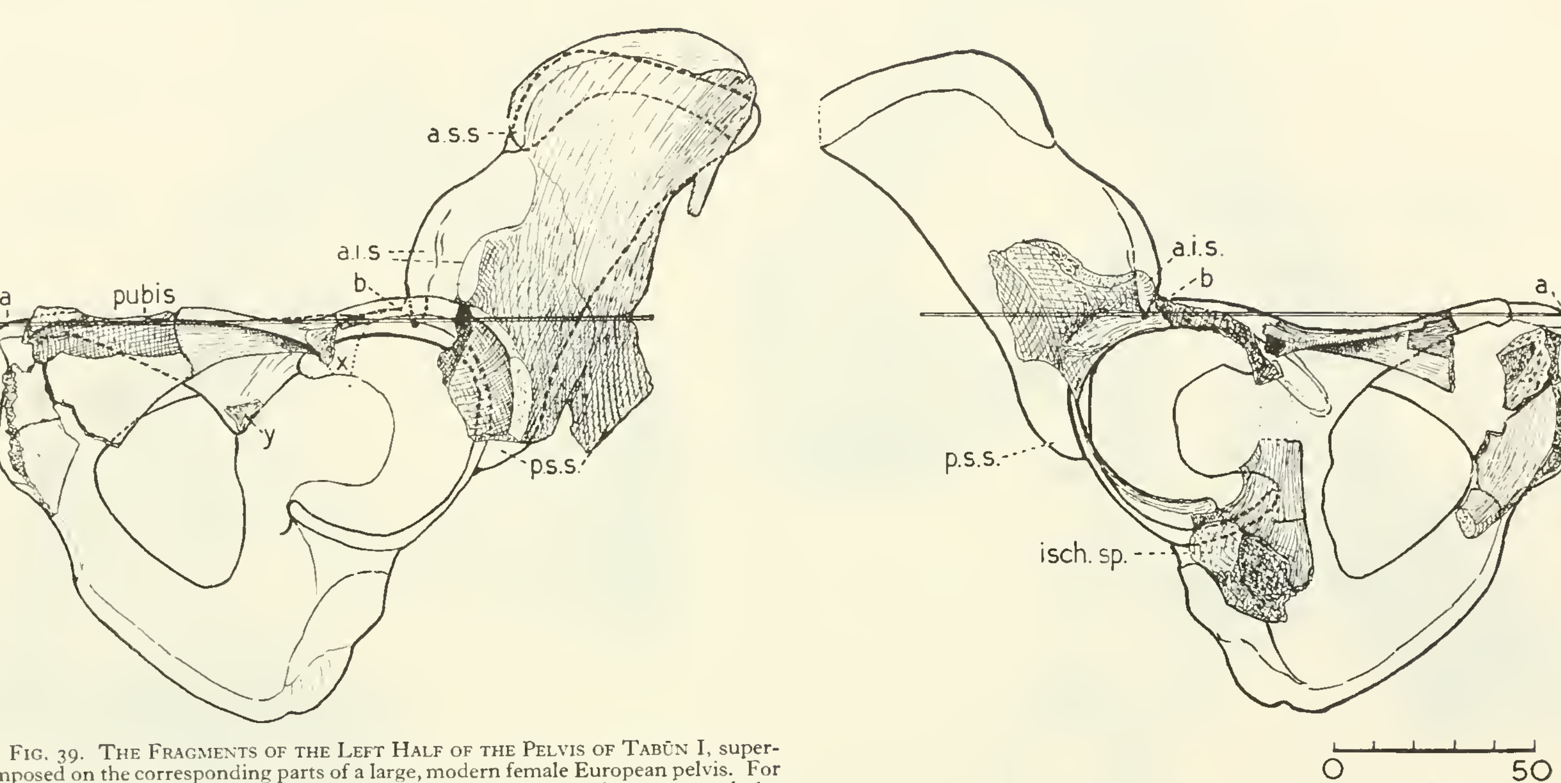


Fig. 39. The Fragments of the Left Half of the Pelvis of Tabūn I, superimposed on the corresponding parts of a large, modern female European pelvis. For further explanation, see text. *a*, pubic (supra-symphysial) point; *b*, supra-acetabular point; the double line crossing these points represents the pubo-acetabular plane; *a.i.s.*, anterior inferior iliac spine; *a.s.s.*, anterior superior iliac spine; *p.s.s.*, posterior superior iliac spine; *y*, fragment of the pubis displaced, but should occupy the position shown at *x*.

Fig. 40. The Parts of the Right Half of the Pelvis of Tabūn I, superimposed on the corresponding parts of a European female pelvis. Letters as in Fig. 39.

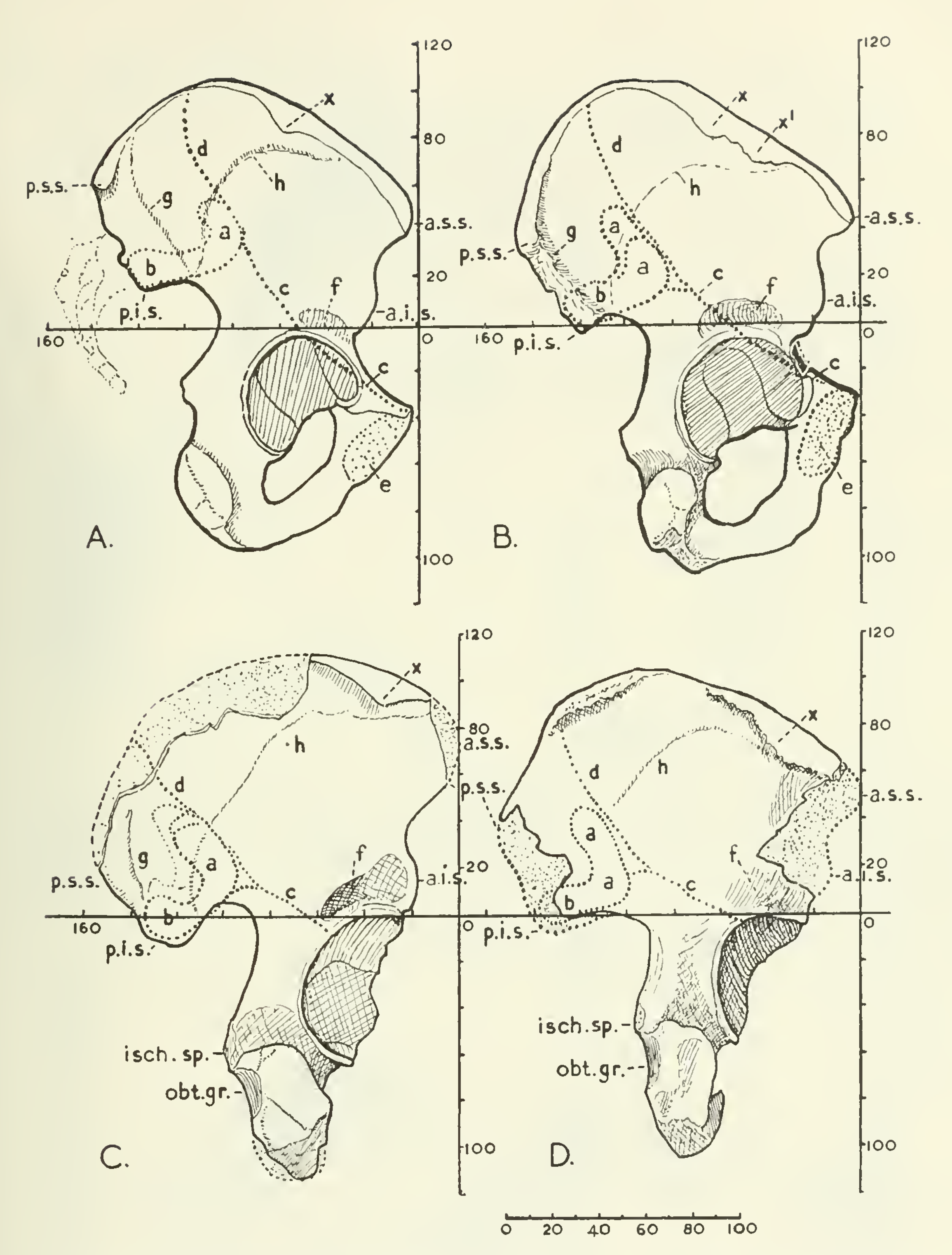


Fig. 41. Lateral Aspect of the Right Os Coxae in a Position of Upright Posture. A, Sikh; B, Skhūl IV; C, Neanderthal (cast); D, Skhūl V. The anterior superior spine is placed in the same vertical plane as the pubic spine. *a*, anterior and ascending part of the sacral articulation; *b*, posterior and horizontal part; *c*, position of linea arcuata; *d*, position of 'anterior ligamentous' line; *e*, symphysis pubis; *f*, supra-acetabular fossa; *g*, superior gluteal line; *h*, inferior gluteal line; *a.i.s.*, and *a.s.s.*, anterior superior and inferior iliac spines; *p.i.s.*, and *p.s.s.*, posterior inferior and superior iliac spines; *isch. sp.*, ischial spine; *obt. gr.*, groove for obturator internus; *x*, *x′*, tubercle of the iliac crest (double in Skhūl IV). The broken lines represent the position of the auricular area for the sacrum, the linea arcuata, and the symphysis pubis. In C and D these areas are missing in the original specimens.

x
a.s.s.
a.i.s.
a.a.
c
acet.
isch. sp.
obt. gr.
isch. t.
0 20 40 60 80 100

42

200
180
140
100
60
20
0
40
80
120
d
p.s.s.
a.a.
inflect
g
h
b
p.i.s.
c
a
180 140 100
isch. sp.
c
acet.
obt. gr.
e
isch. t.

43

Fig. 42. A Reconstruction of the Lateral Profile of the Right Os Coxae of Tabūn I. The shaded areas are taken from the right bone, the unshaded from the left; the area enclosed by a stippled outline is missing. *a.a.*, part of the auricular articular area; *c*, position of linea arcuata; *x*, tubercle of the crest; *a.s.s.*, *a.i.s.*, anterior superior and anterior inferior iliac spines; *isch. sp.*, ischial spine; *isch. t.*, ischial tuberosity; *obt. gr.*, groove for the obturator internus; *acet.*, acetabular cavity. The pubic elements are shown in Figs. 39, 40 (one half natural size).

Fig. 43. Lateral Aspect of the Right Os Coxae of an Adult Male Gorilla (one-quarter natural size). The shaded area ('inflect.') represents a deep gutter or inflection, between the articular and pre-articular areas of the ilium. The vertical line represents the pubo-spinal plane on which the human bones have been orientated. The horizontal crosses the supra-acetabular point (*a*). Letters have the same significance as in Fig. 41.

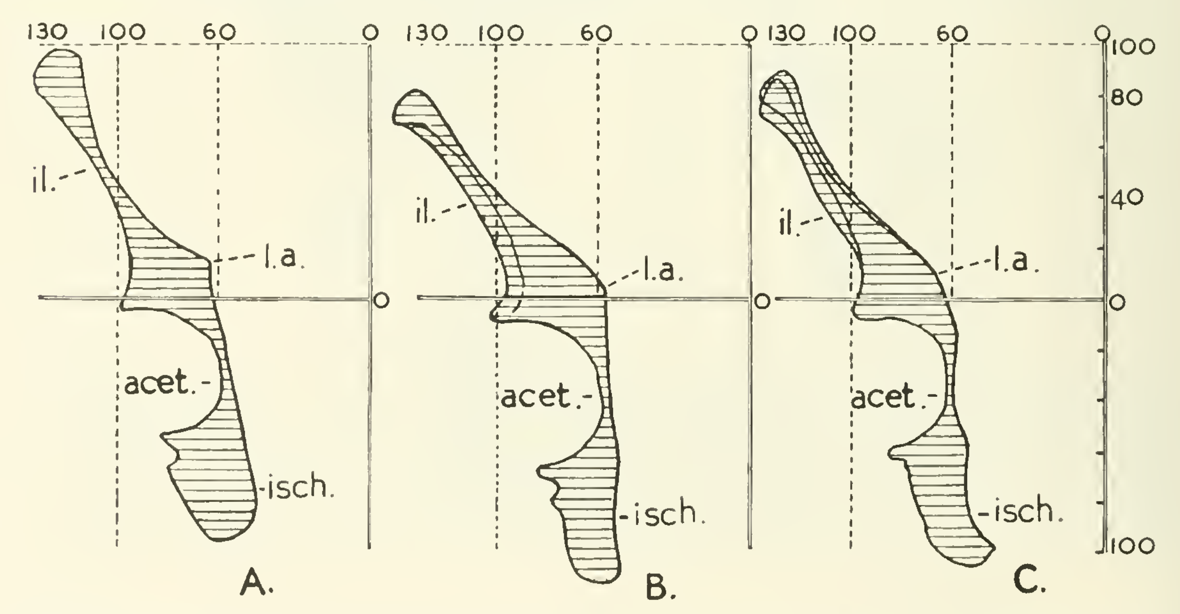


Fig. 44. Vertical Sections of the Os Coxae. A, Sikh; B, Neanderthal (cast); C, Skhūl IV. The sections are drawn at their normal distance from the mid-plane (sagittal) of the pelvis. *acet.*, acetabulum; *l.a.*, linea arcuata; *il.*, iliac lever; *isch.*, ischial lever.

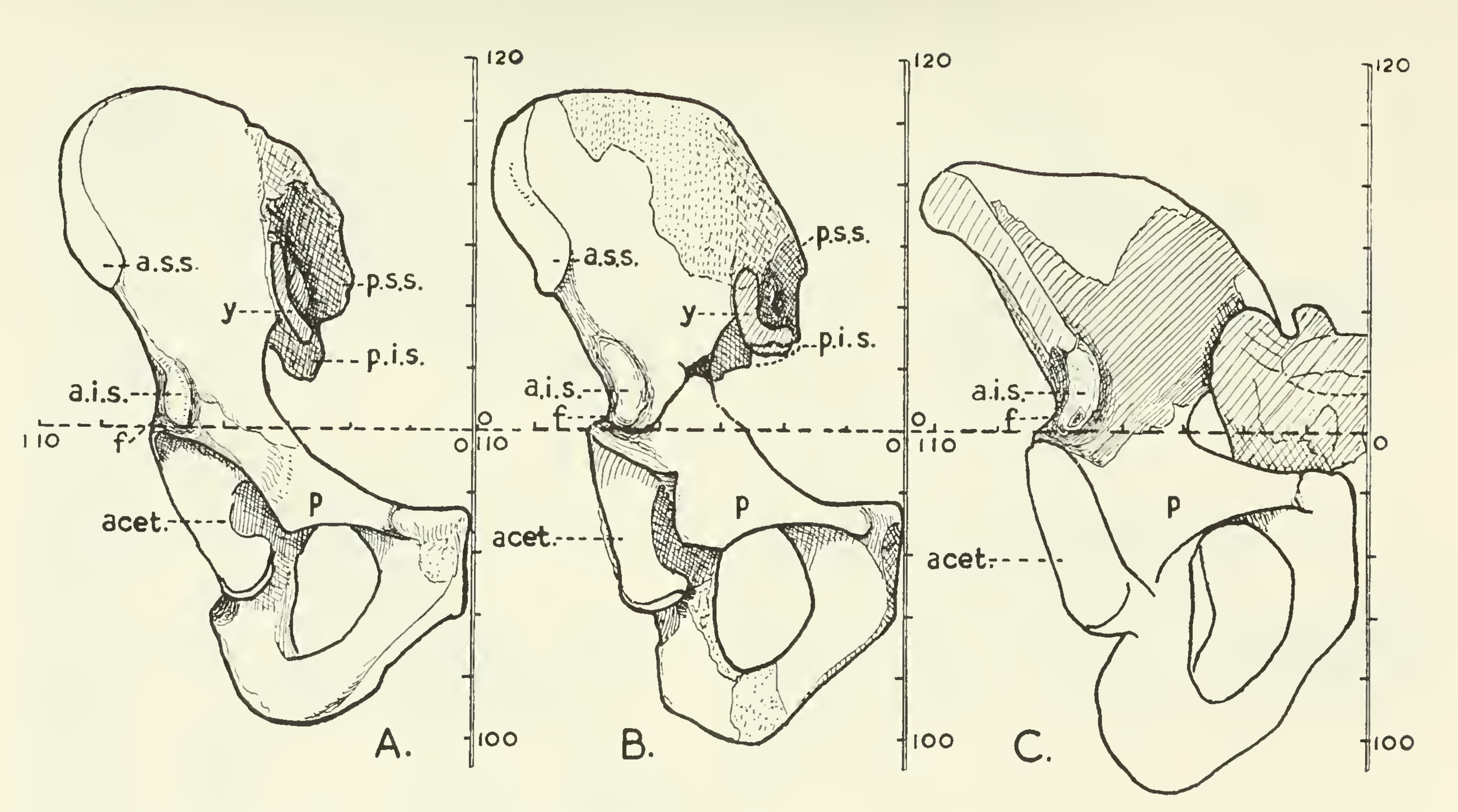


Fig. 45. Anterior Aspect of the Right Os Coxae in the Erect Position of the Body. A, Sikh; B, Skhūl IV; C, La Chapelle (reconstruction after Boule). The vertical lines represent the mid-sagittal plane of the body. *acet.*, acetabulum; *a.i.s.*, anterior inferior iliac spine; *f*, supra-acetabular fossa and projecting upper brim of the acetabulum; *p*, pubis; *p.i.s.*, *p.s.s.*, posterior inferior and posterior superior iliac spines; *y*, auricular area for articulation with the sacrum.

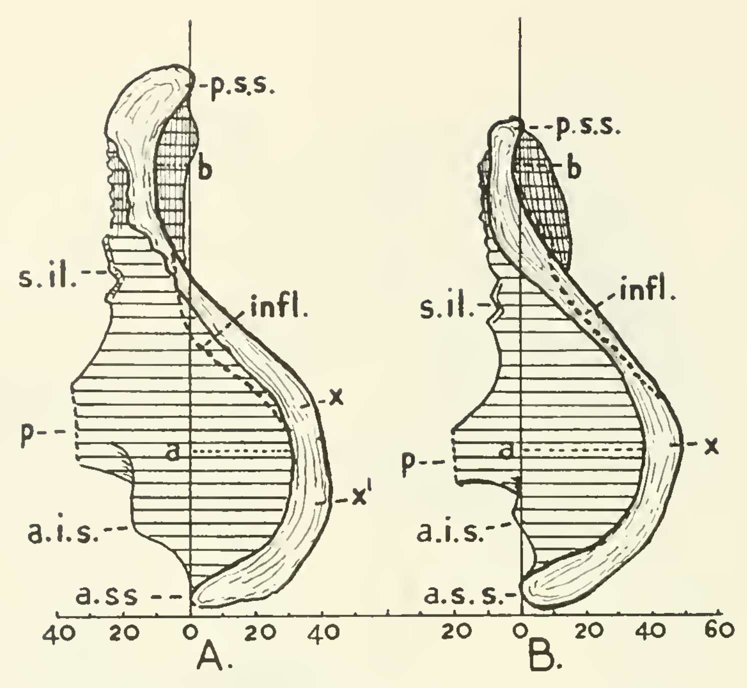


Fig. 46. The Curvature of the Iliac Crest. A, Skhūl IV (left); B, Sikh. The specimens are orientated so that the anterior superior spine is level with the posterior superior spine, and the lateral margin of the posterior spine is in the same vertical plane as the tip of the anterior spine. *a.s.s.*, anterior superior iliac spine; *p.s.s.*, posterior superior iliac spine; *a.i.s.*, anterior inferior iliac spine; *p*, section of pubis; *s.il.*, sacro-iliac articulation; *x*, tubercle of crest; *infl.*, inflection of ilium; *a*, depth of anterior internal concavity; *b*, depth of posterior external concavity.

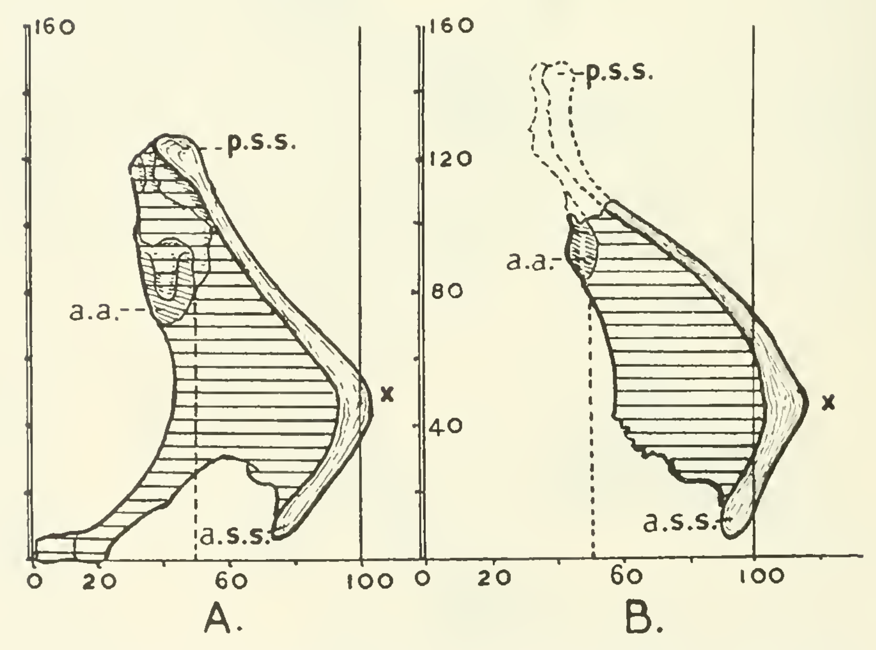


Fig. 47. The Left Os Coxae placed in the Erect Position and Viewed from above. A, Bushman; B, the fragmentary ilium of Tabūn I (placed in an approximately similar posture; the posterior part, represented by stippled lines, being an attempted restoration). *a.a.*, auricular articular area; *x*, tubercle of the iliac crest; *a.s.s.*, *p.s.s.*, as in previous Figures.

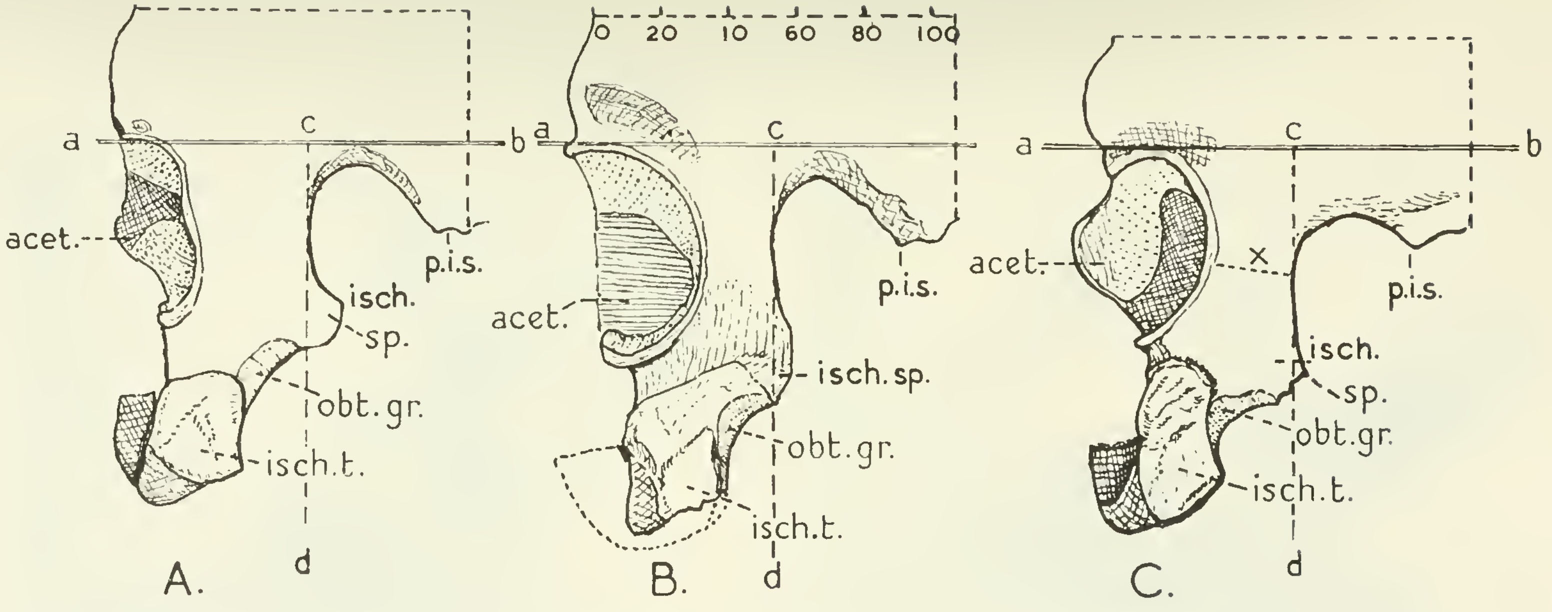


Fig. 48. The Ischial Region of the Os Coxae. A, Sikh; B, Neanderthal; C, Skhūl IV. The bones were drawn from the same point of view, and were orientated so that the posterior inferior spine lay directly behind the anterior margin of the sciatic notch, this margin being placed in a vertical position. *acet.*, acetabulum; *obt. gr.*, obturator groove; *isch.t.*, ischial tuberosity; *isch.sp.*, ischial spine.

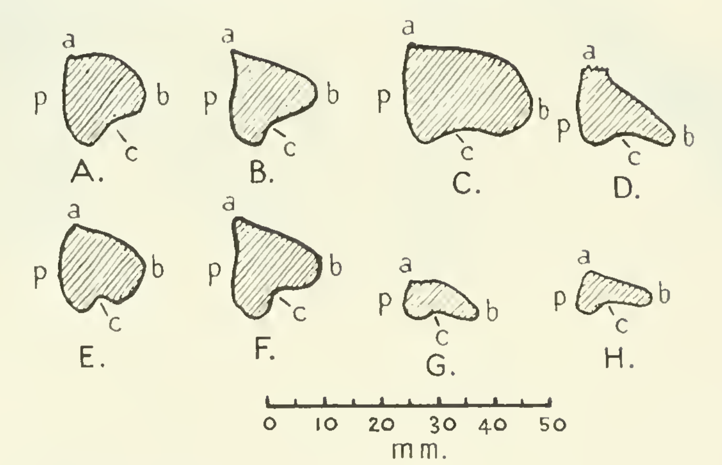


Fig. 49. Sections of the Pubis made along the Line *x–y*, shown in Figs. 50, 51. A, Sikh; B, English (Iron Age male); C, Skhūl IV; D, Gorilla; E, European female (modern); F, Skhūl IX; G, Tabūn I (left); H, Tabūn I (right). *a*, linea arcuata (ileo-pectineal); *b*, anterior or ventral margin; *p*, pelvic aspect; *c*, groove for the obturator nerve.

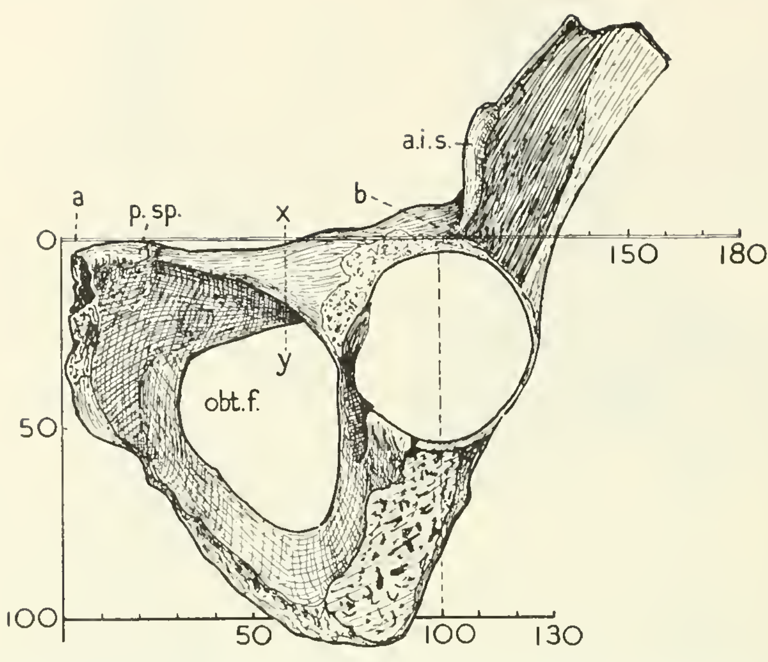


Fig. 50. Pubis and Ischium of Skhūl IX. Orientated on the pubo-acetabular plane (the double horizontal line). *a*, supra-symphysial point; *b*, supra-acetabular point; *a.i.s.*, anterior inferior iliac spine; *p.sp.*, pubic spine; *obt.f.*, obturator foramen; *x–y*, line of section shown in Fig. 49.

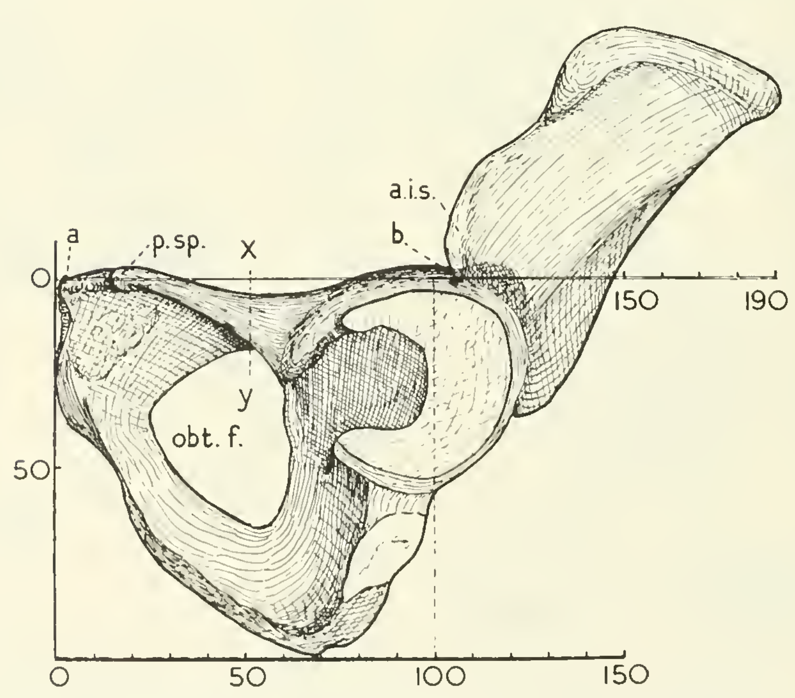


Fig. 51. Modern European (British) Female Pelvis, orientated and drawn as is the pelvis of Skhūl IX (cf. Fig. 50, the letters having the same significance).

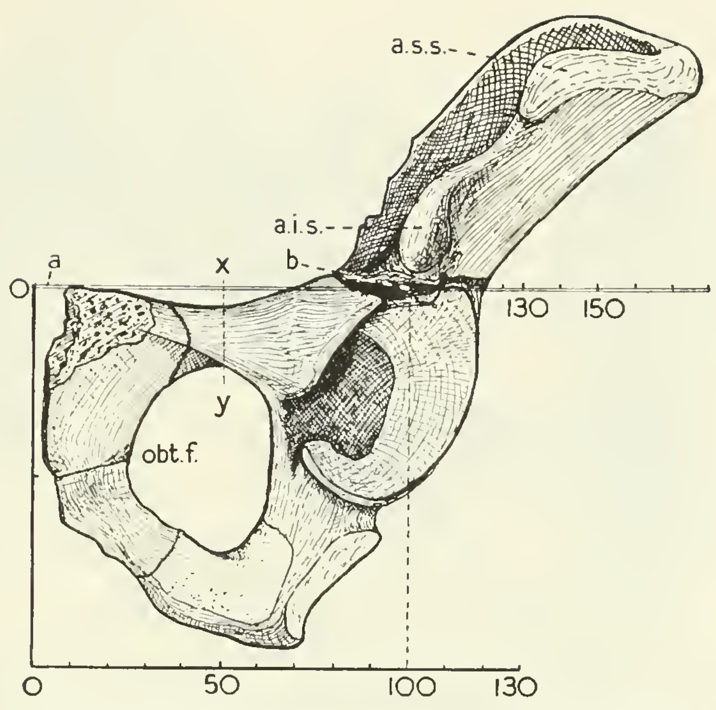


Fig. 52. The Pelvis of Skhūl IV, orientated and shown as in the two previous figures (Figs. 50, 51). Letters have the same significance.

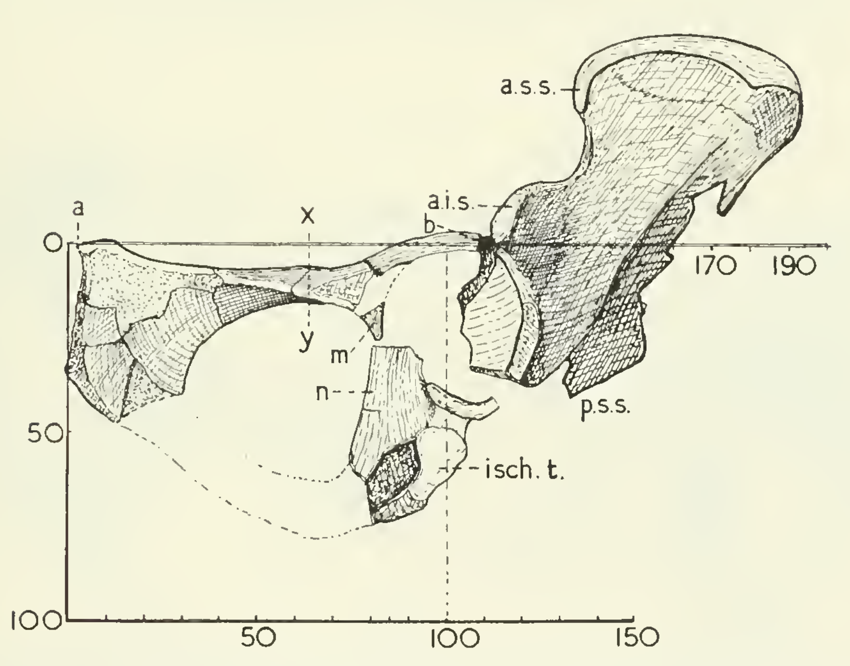


Fig. 53. The Various Parts of the Left Half of the Pelvis of Tabūn I, grouped together and drawn from the same point of view as in Figs. 50–2. *m*, a fragment of the pubic wall of the acetabular cavity; *n*, obturator margin of the ischium; *isch. t.*, ischial tuberosity (from the right side). The ilium has been given the same position as in Fig. 51, but the flattening of its dorsal part made an exact orientation impossible.

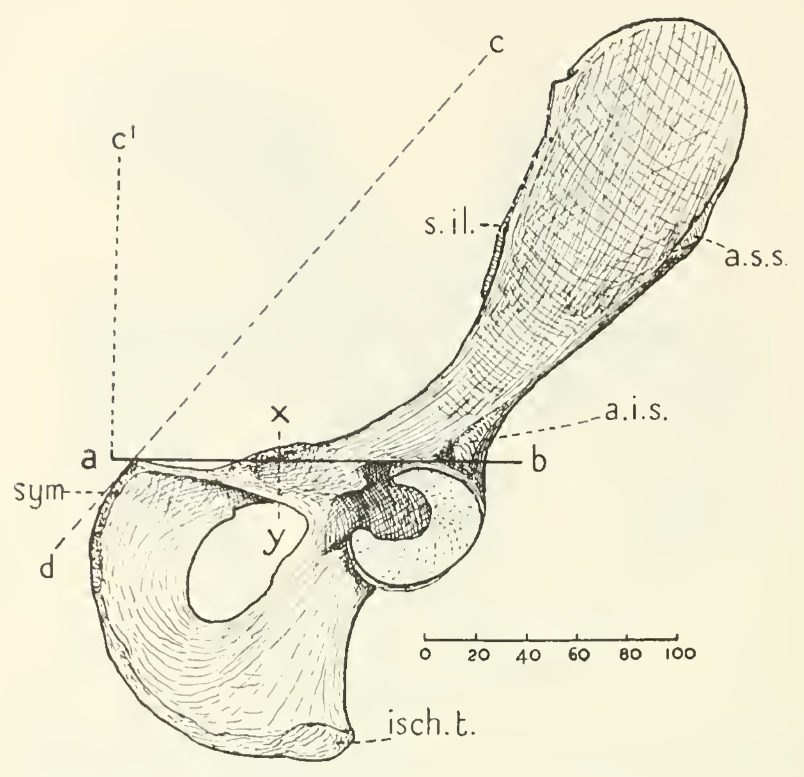


Fig. 54. The Left Os Coxae of a Male Gorilla, orientated in the pubo-acetabular plane (*a–b*). *c–d*, mid-line of the body; *sym*, symphysis pubis; *s. il.*, sacro-iliac articulation; *isch. t.*, ischial tuberosity. Further explanation in text.

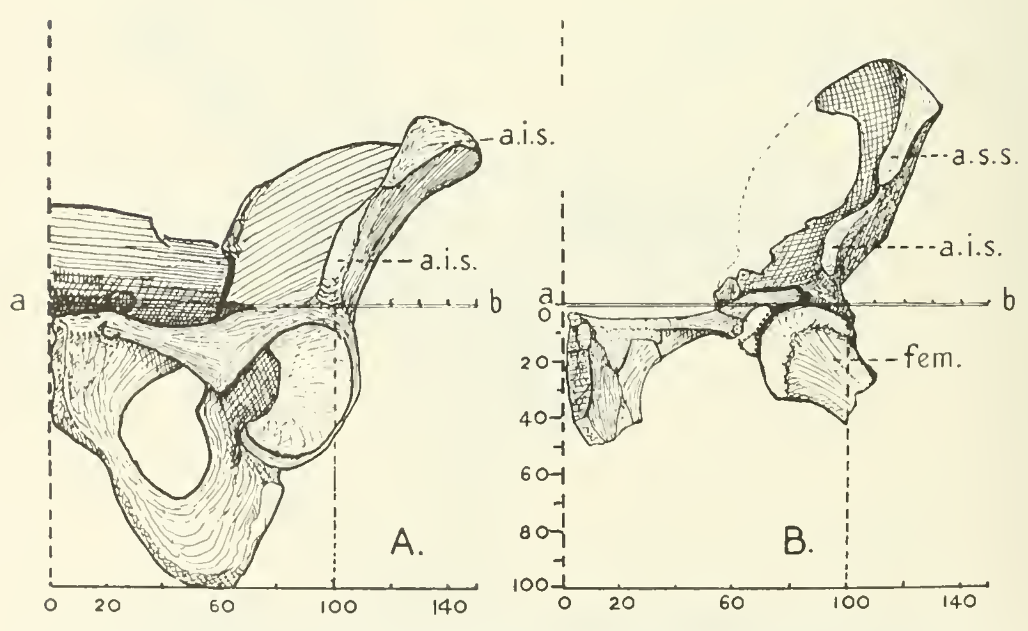


Fig. 55. A. Left half of the pelvis of a modern European (British) female, orientated in the antero-posterior plane of the body, with the inlet of the true pelvis in the horizontal plane. B. The parts of the left half of the pelvis of Tabūn I orientated in the same manner. *fem.*, head and neck of the femur.

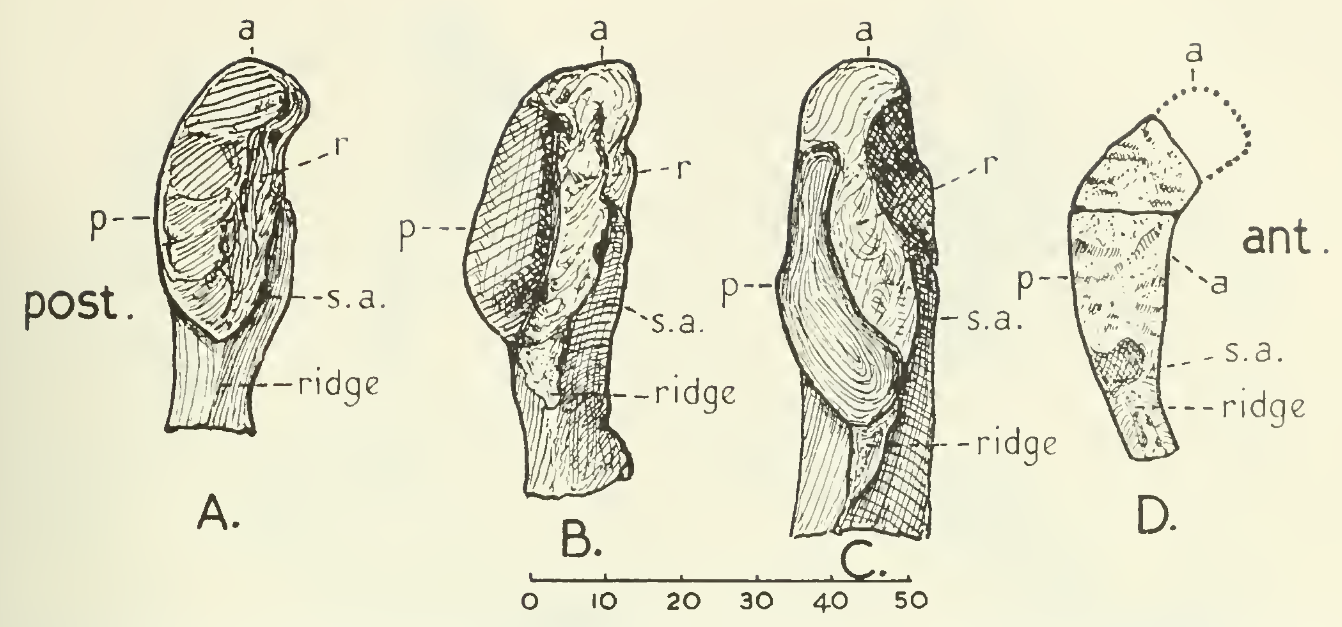


Fig. 56. The Articular Aspect of the Left Symphysis Pubis. A, Sikh; B, Skhūl IV; C, Skhūl IX; D, Tabūn I (right, reversed). *p*, Todd's 'platform', on the dorsal or pelvic border of the symphysis; *r*, Todd's 'rampart'; *s.a.*, smooth area; *a*, supra-symphysial point; *ridge*, ridge on the sub-pubic arch for attachment of the transverse ligament; *post.*, posterior surface; *ant.*, anterior surface.

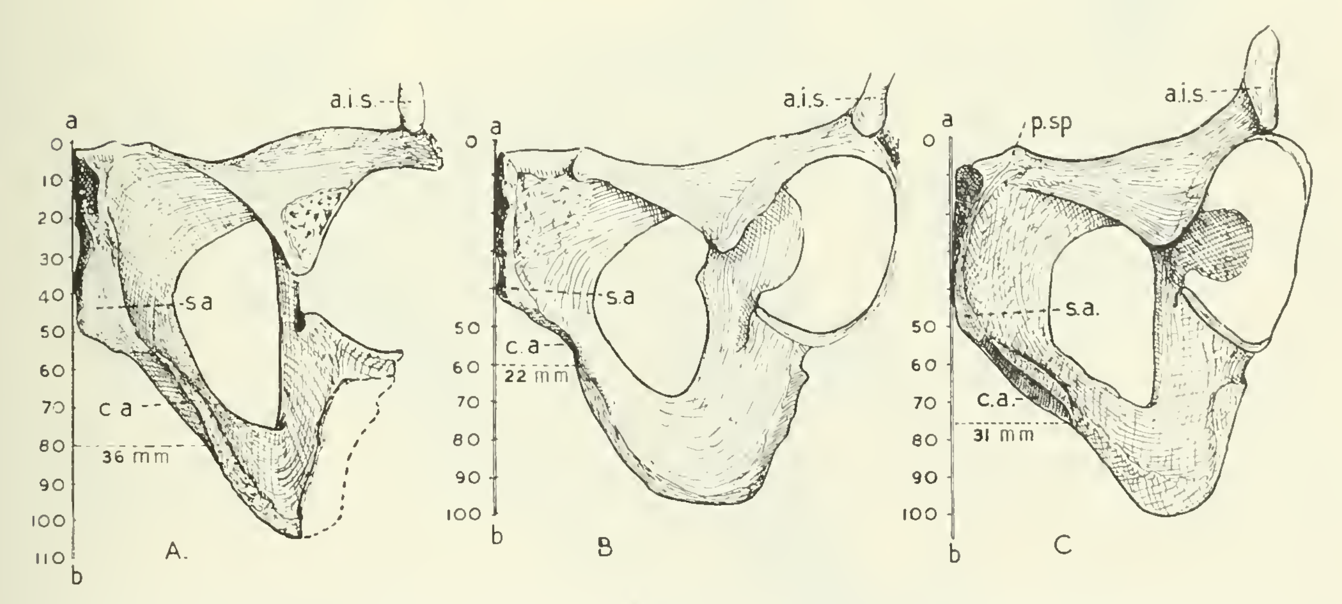


Fig. 57. The Pubic Arch. A, Skhūl IX; B, European female (modern); C, Skhūl IV. The orientation is described on p. 85. The horizontal line indicates the measurement of the width of the arch. *c.a.*, area of attachment for the crus penis; *s.a.*, smooth area.

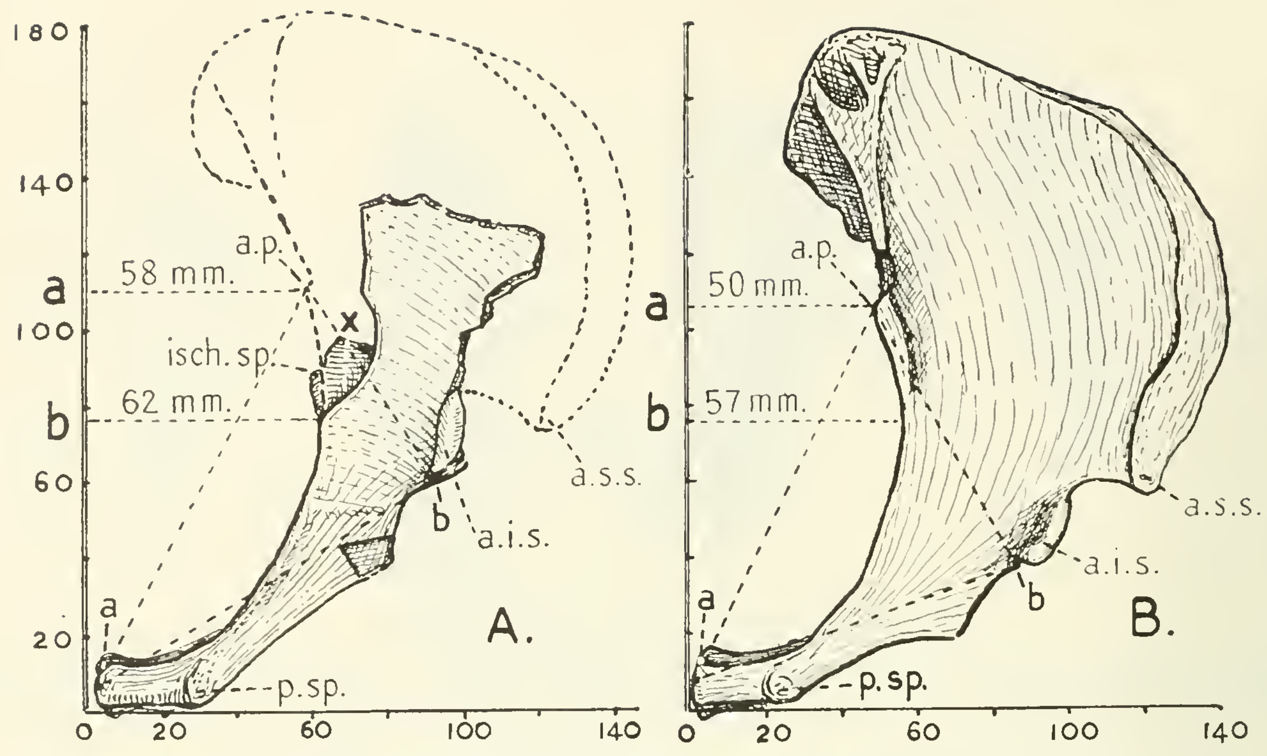


FIG. 58. THE LEFT OS COXAE, viewed at right angles to the brim and orientated in the pubo-acetabular plane. A, Skhūl IX (the missing parts are represented by a broken line and are based upon the accompanying drawing of Skhūl IV); B, Skhūl IV. *a*, supra-symphysial point; *b*, supra-acetabular point; *a.p.*, auricular point; *isch. sp.*, ischial spine; *p.sp.*, pubic spine; *x*, point of entrance of implement to pelvic cavity (p. 74). Diameters: *a*, bi-auricular; *b*, maximum transverse.

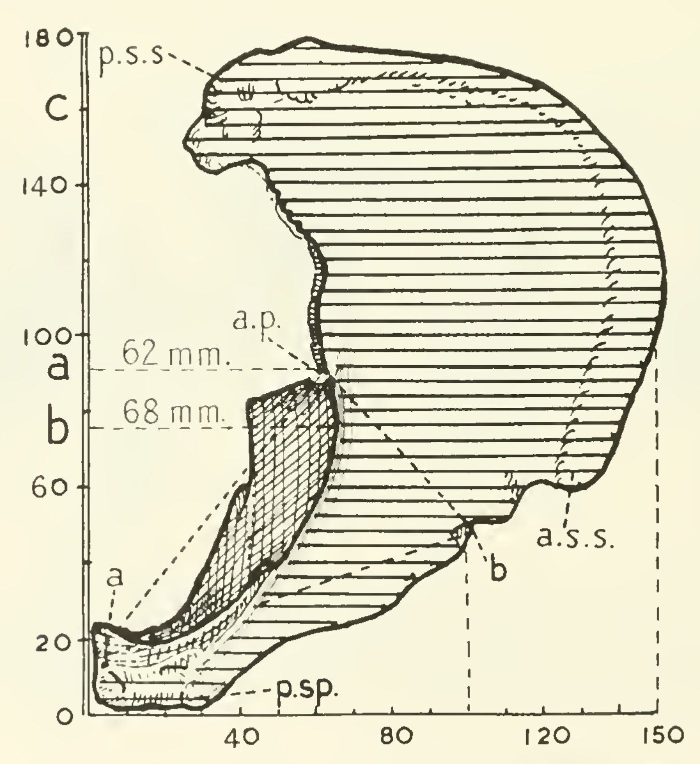


FIG. 59. THE LEFT PELVIS OF THE GROTTES DES ENFANTS MALE (after Verneau). Orientated and lettered as in Fig. 58.

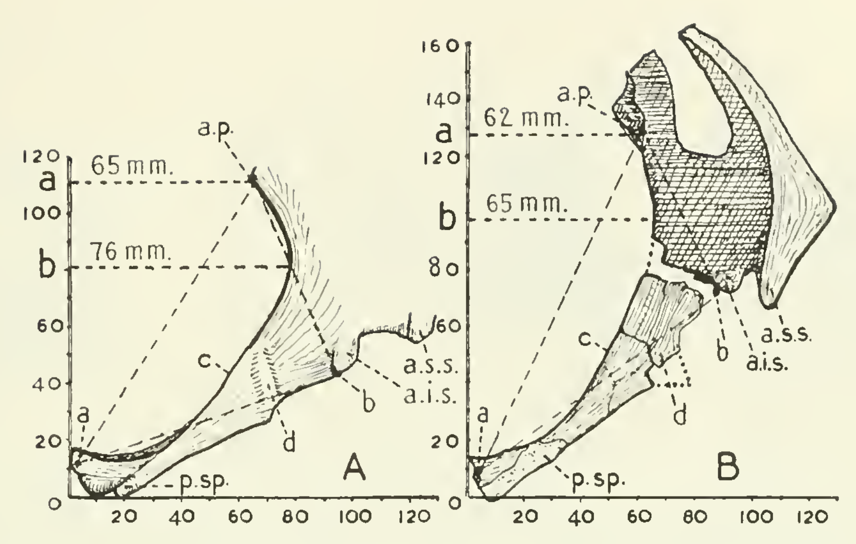


FIG. 60. THE LEFT PELVIS VIEWED AT RIGHT ANGLES TO THE BRIM AND ORIENTATED ON THE PUBO-ACETABULAR PLANE. A, European female (modern); B, Tabūn I (reconstruction). *a*, supra-symphysial point; *a.p.*, auricular point; *b*, supra-acetabular point; *c*, ileo-pectineal line; *d*, ileo-pectineal eminence; *p.sp.*, pubic spine. Diameters: *a*, bi-auricular; *b*, maximum transverse.

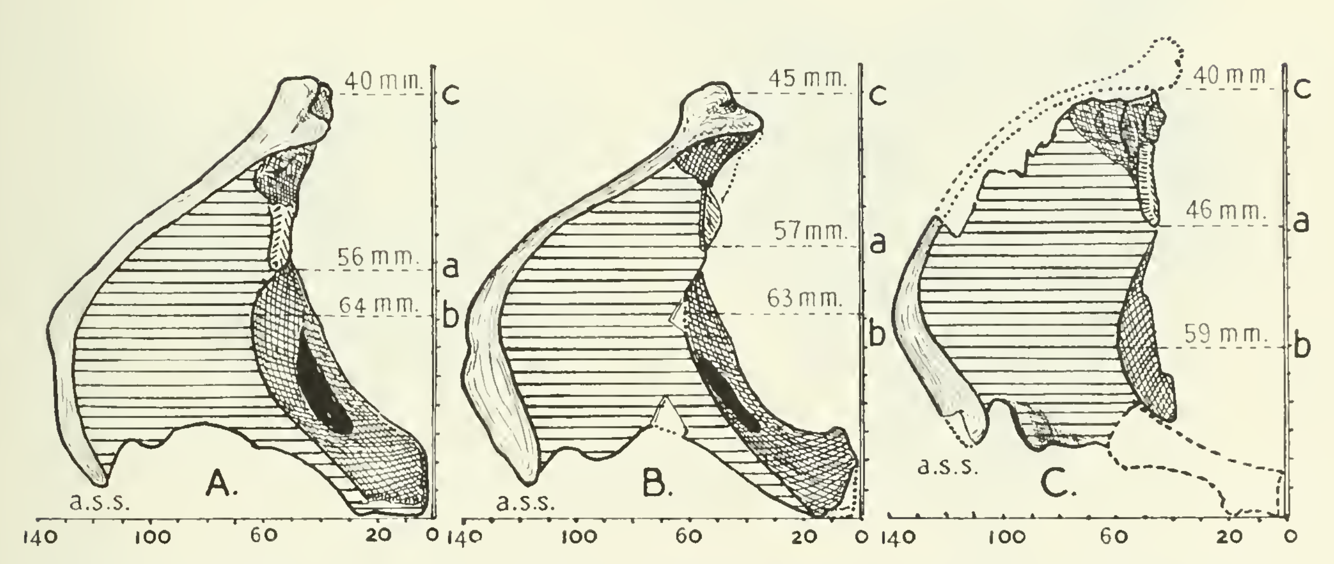


FIG. 61. THE RIGHT HALF OF THE PELVIS ORIENTATED IN THE UPRIGHT POSTURE AND DRAWN FROM ABOVE. A, Sikh; B, Skhūl IV; C, Neanderthal (restoration). *a.s.s.*, anterior superior spine. Diameters: *a*, bi-auricular; *b*, maximum transverse; *c*, distance between the posterior superior spines.

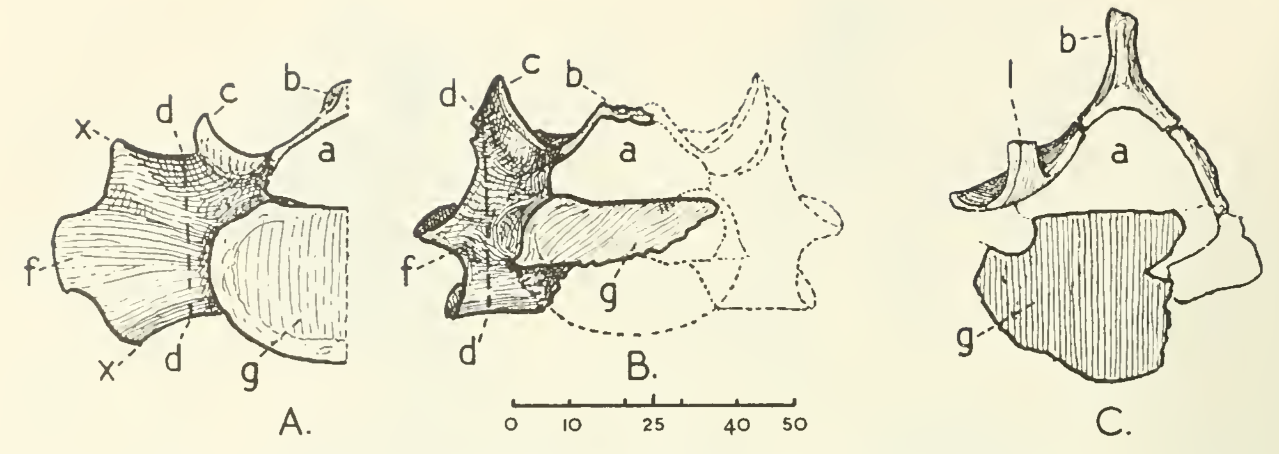


Fig. 62. Basal View of the Right Half of the Sacrum. A, Bushman; B, fragments of Skhūl V; C, fragments of Skhūl IV. *a*, vertebral canal; *b*, spinous process; *c*, articular process; *d–d*, plane along which the dorso-ventral diameter of the lateral mass is measured; *x*, *x*, margin of the auricular surface of the sacrum; *f*, costal element of the lateral mass; *g*, body of the first sacral vertebra; *l*, lamina of the first sacral vertebra at the point where it joins the articular process.

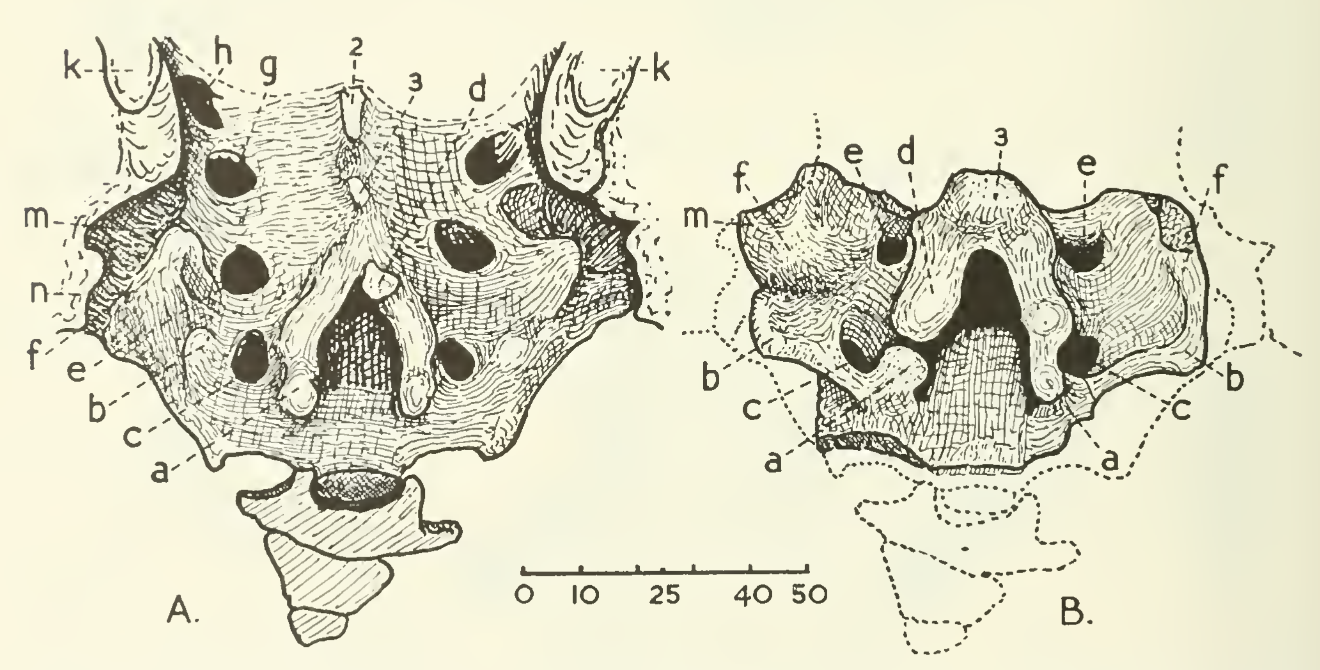


Fig. 63. Dorsal Aspect of the Sacrum. A, Sikh; B, fragment of Skhūl IV, consisting of part of the third, fourth, and fifth sacral vertebrae. The stippled outline surrounding it is the outline of the Sikh bone. 2, spine of the second vertebra; 3, spine of the third vertebra. *a*, rudiment of the dorsal arch of S 5; *b*, part of the lateral mass, which represents the tip of the transverse process of S 5; *c*, foramen for dorsal branch of the fourth sacral nerve; *d*, rudimentary dorsal arch of S 4; *e*, third sacral foramen; *f*, part of the lateral mass representing the transverse process of S 4; *g*, second sacral foramen; *h*, first sacral foramen; *k*, posterior superior spine of ilium; *m*, costal element of the lateral part of S 4 and S 5, passing under the spines of the ilium; *n*, posterior inferior spine of ilium.

CHAPTER VII

THE VERTEBRAL COLUMN

CERVICAL REGION (Pl. IX; Figs. 64, 65, 66, 67)

THE cervical vertebrae of only one individual, Skhūl V, are preserved in their entirety. We give a drawing of his neck vertebrae, seen in profile in Fig. 64 A, the first time a representation has been given of this part of the vertebral column of mid-Pleistocene cave humanity. Boule gives a photograph, in profile, of the fifth, sixth, and seventh cervical vertebrae of the La Chapelle man. We have enlarged this photograph to natural size and reproduced the drawing of it in Fig. 64 C. Kramberger found the same series at Krapina, belonging to an adult male, and his photograph of the specimens leaves no doubt as to the similarity which existed between the vertebrae of the Krapina and the La Chapelle individuals. Nor can there be any doubt as to the resemblance between these and the corresponding parts of the Skhūl male. In the Skhūl neck, as in the European Neanderthal, the spinous processes of the fifth, sixth, and seventh vertebrae are long and project horizontally backwards. The condition of the spinous processes in modern native races may be judged from the drawing given of a Bushman's neck (Fig. 64 B). We may say now that in none of the Skhūl cervical vertebrae is the tip of the spinous process divided. In their length, the horizontal position and the undivided tip, the Skhūl and Neanderthal cervical spines resemble each other and also those of the anthropoids.

Readers may wonder why we have selected the neck of a Bushman, one of the smallest of the modern races, as the subject for comparison with one of the tallest of fossil men known to us. The Bushman's femur is 400 mm. long; in Skhūl V it is 518 mm. The one must have been nearly 250 mm. taller than the other. Our primary reason was because of certain points of resemblance in their cervical vertebrae, which we shall touch upon presently. The comparison serves first to bring out the relative shortness of the Skhūl neck. Measured by calipers from the upper margin of the anterior arch of the atlas to the lower border of the body of the seventh cervical vertebra, the distance in the Bushman is 91 mm.; in Skhūl V, 97·5 mm. If we measure along the anterior curve of the column, between the same points, the distance in the Bushman is 94 mm.; in Skhūl V, 104 mm. Martin gives the length of the cervical curve in Europeans as varying from 110 mm. to 140 mm. From this it will be seen how remarkably short is the neck of Skhūl V, for so tall a man. Unfortunately we do not know if this feature, like his very long femur and humerus, is an individual or a racial character.

We know nothing of the characters of the necks of the other Skhūl people or of the Tabūn woman. There is reason to believe that the Neanderthal people of Europe were short necked. Kramberger gives measurements of the Krapina example—the fifth, sixth, and seventh cervicals—which, as in the La Chapelle skeleton, were fixed together in their normal articulation. The total depth of the column from the upper border of the fifth to the lower border of the seventh was 37 mm. Boule gives no measurements for La Chapelle, but from his photograph we estimate that the depth was the same, 37 mm. This measurement in Skhūl V, in which the sixth and seventh are fixed with the first

and second dorsal vertebrae, is almost the same, namely, 36 mm. It is probable, however, that it was somewhat less in life, for an inspection of Fig. 64 A will show that there has been pressure on the borders of the lower cervical vertebrae which has pushed them downwards against the bodies of the dorsal vertebrae. In the spine of an Australian male these vertebrae (C. 5, 6, 7) give the same depth, 36 mm.; in the Bushman the amount is 34·5 mm., but in a Sikh it is 45 mm., a measurement equal to that prevailing in European males.

Kramberger was astonished by the relative slenderness and small size of the upper cervical vertebrae of the Krapina people; that, too, was the impression produced on us by the cervical vertebrae of Skhūl V. Had these vertebrae been found apart from the skull we should have been reluctant to assign them to it. The small size of the cervical vertebrae, the shortness of the neck, the length of the spinous processes of the fifth and sixth vertebrae of Skhūl V must be regarded as Neanderthaloid characters. Yet we find somewhat similar characters in modern native races. When we compare the modern neck, such as that of the Bushman (Fig. 64 B), with that of Skhūl V we see that their difference depends upon mobility. The ancient neck is short, stiff, and strong; the modern neck sacrifices strength to mobility. This is especially seen in the posterior system of levers, the spinous processes. Only the posterior lever of the seventh is long and strong in the modern neck, to give power to the muscles of the back. In Skhūl V, as in La Chapelle and Krapina, the sixth also has a long lever; the fifth also has undergone reduction as compared with the anthropoids. Both sixth and seventh are fulcral in Skhūl V; the fifth is in an intermediate stage. The vertebrae above have short spines and are freely mobile. Further, it will be seen that the reduction of the spines and the wide gap between the fifth and sixth spines gives modern man the power of throwing his head backwards (Fig. 64 B). The lengths of the spinous processes are given in Table XXV (p. 111).

The Skhūl neck differs from the modern in another respect. The articular processes of the cervical vertebrae (Fig. 64 A) build strong lateral supporting columns. The articular surfaces of these processes are nearly horizontal in the Skhūl neck; the angle they form with the lower border of the adjacent lamina varies from 160° to 170°. They are more oblique in the Bushman, as in most modern necks, the angle varying from 125° to 135°. It is important to realize that there is a triple supporting column in the neck; there is first that formed by the bodies, and in addition a column formed at each side by the articular processes. The weight of the head is transferred to the upper surface of the axis through the atlas; from the axis the weight is transferred by all three columns. In the Skhūl neck, and one suspects that this was also the case in the Neanderthal neck, the lateral columns play a more important part in supporting the head than in the modern neck. The lateral columns are adapted to mobility in the modern neck and this is also true in the chimpanzee neck; it is the Skhūl form which is the modified or specialized one.

THE ATLAS

There are no measurements of a complete example of this bone from Neanderthal skeletons. The best specimen is that of La Chapelle man, which we have measured from the photograph given by Boule. From this we have made an enlarged drawing,

reproduced in Fig. 65 B, for comparison with the Skhūl specimen. There were only two fragments of atlas found at Krapina.

The upper or cranial aspect of the atlas of Skhūl V is represented in Fig. 65 A. It will be seen that the transverse processes have been broken away and that the left lateral mass has been fractured, attended by a displacement which we found impossible of adjustment. Beside it is a drawing of the La Chapelle atlas, enlarged to scale, from Boule's photograph. It lacks the posterior arch, yet the resemblance is evident. We have fitted the posterior arch of the Skhūl atlas to it and it fits as far as dimensions are concerned. In addition there are shown two contrasted types of modern atlas, the delicate form, represented by the Bushman specimen (Fig. 65 C), and the robust type by that of a Sikh (Fig. 65 D). The fossil specimens are of the slender type.

The measurements of the atlas are given in Table XXIII (p. 110). It is unnecessary to analyse these measurements except to point out the correspondence between the Skhūl and the La Chapelle figures, and the ample size, particularly as regards length of the neural canal. There is no anatomical feature which separates the atlas of the Bushman from that of either Skhūl or La Chapelle. Certainly in the Skhūl specimen the median tuberosity of the anterior arch has none of the anthropoid affinities which Boule saw in that of La Chapelle. The facet for the odontoid process on the anterior arch of Skhūl V measures 8·5 mm. wide by 10 mm. vertically, but it nowise differs from the modern facet in shape or dimensions.

Views of the anterior aspect of the atlas of Skhūl V, compared with the corresponding view of the atlas of a Bushman, are given in Fig. 66. Both are in articulation with the axis. The width of the body of the atlas is almost the same, as may be seen from the measurements given in Table XXIII (p. 110), but in vertical height the lateral masses of the Skhūl specimen are the deeper. An outline of the corresponding view of the La Chapelle atlas fits perfectly with our drawing of the Skhūl bone.

THE AXIS

The first point which impresses one concerning the Skhūl axis is its smallness. This is apparent in Fig. 66, where its anterior aspect is compared with that of the Bushman axis, and it is seen more noticeably in the lateral view presented in Fig. 67 A, upper series A. Comparative measurements of the axis are given in Table XXIV (p. 111).

The anterior aspect reveals the squat form of the body and the low vertical height of the lateral masses which support the atlas. This is also brought out in Table XXIV (p. 111). The odontoid is also short but its diameters and its articular surfaces differ very little from those with which we compared it. It is inclined forwards to a slightly greater degree than in modern vertebrae, whereas in the La Chapelle axis the forward inclination is almost that of the anthropoid state. The lowness of the body and the shortness of the odontoid are not characters of the Krapina axis (Fig. 67 A, upper series B). The articular surfaces for the atlas in the Skhūl specimen are moulded as in modern bones; the contour across the surface from the medial to the lateral border shows a slight convexity medially, a slight concavity laterally. The vertebral canal is wide transversely (Table XXIV, p. 111).

There is a marked degree of similarity between the Skhūl and the Krapina axes (Fig. 67 A, upper series A, B). This is particularly noticeable in the manner of the attachment

of the dorsal arch to the body of the vertebra. The upper margin of the arch in the Krapina axis runs backwards, continuing on the level of the hinder margin of its upper articular surface (Fig. 67 A, upper series B, *l,f*). The upper laminar border of the Skhūl axis has approximately the same direction as in the Krapina axis. In the two modern bones, exemplified in Fig. 67 A, upper series C, D, the upper laminar margin is seen to bend downwards as it leaves the body of the axis and then turns upwards (cranially) as it passes backwards. The Bushman axis (Fig. 67) shows an exaggeration of the Australian form (Fig. 67); yet the Bushman form is that which we meet with in the axis of the chimpanzee. It is the Skhūl vertebra which has become specialized or modified.

The lower articular surface of the axis is placed on the under surface of the laminar arch. The difference in inclination of this surface in the Skhūl and the Bushman axes is very marked (Table XXIV, line 8, p. 111). The significance of this character has already been mentioned (p. 94).

One other feature of the axis of Skhūl V which deserves mention is the condition of its spinous process. It is a rough triangular elevation rather than a true spinous outgrowth. The lengths of this process are given in Table XXIV, line 5 (p. 111); in both the Bushman and the Sikh bones there is a definite process, with a bifid, spread extremity. This has a breadth of 17·5 mm. in the Sikh and of 16·5 mm. in the Bushman. The Skhūl axis evidently had a weak dorsal lever. In one Krapina axis, however, Kramberger found a strong spinous process, comparable to that seen in our Bushman specimen.

Tabūn I.

The cervical vertebrae of Tabūn I have entirely disappeared except for five fragments. The first of these represents half of the posterior arch of the atlas from the groove for the vertebral artery on the right side to the site for the posterior tubercle. The groove is better marked than in Skhūl V, resembling that of the Bushman. The lateral segment of the arch is wide and shallow (7·5 × 4·6 mm.) and the tubercle is flat and smooth (Table XXIII, p. 110). The total length of the fragment is 26 mm. indicating that the posterior arch must have been short.

A second fragment we take to be the right half of the anterior arch of the atlas bearing the impression for the odontoid process. The fragment is wide and shallow (9·2 × 3·3 mm.) and the length, 12·5 mm., again suggests a short arch.

There are two fragments of the axis consisting chiefly of the right (Fig. 67 B, lower series) and left inferior articular processes, the ventral part of the laminar arch and parts of the articular surfaces for the atlas. The conformation of these pieces is peculiar. In Fig. 67 B, lower series B, B′, is shown the caudal aspect of the Tabūn fragment, placed beside the same part of a Bushman axis. The lower articular surface in the Tabūn woman is deeply concave and appears as though it were pressed into the root of the arch, not free and upstanding as in modern bones. The surface is extensive, being relatively wide (9·5 mm.) for its length (11 mm.), it looks forwards and inwards, not forwards and a little outwards as in the modern axis, and forms a very shallow angle (160°) with the lower border of the arch. Another related feature is shown in Fig. 67 B, lower series A, A′. The hinder and lateral margins of the Tabūn articular process, when viewed from above, form a sharp corner, almost a right angle. The modern form is rounded or oval. The lamina of the arch was thick and stout and the pedicle was short. It has

resemblances to the axis of Skhūl V in the shallow angle and the extensiveness of the articular area but was clearly much smaller in all its chief dimensions.

The fifth fragment is a cervical spinous process, 18 mm. long, which probably belongs to the third or fourth cervical segment. It was thick at the base but tapered rapidly to a sharp, spike-like point, very similar to the condition seen in the cervical spines of Skhūl V (Fig. 64 A, Cervical 5). The Tabūn form is even more simian in appearance than are the Skhūl examples.

CERVICAL VERTEBRAE, THIRD TO SEVENTH

The measurements of the cervical vertebrae below the axis are given in Table XXV (p. 111). We propose to concentrate upon a representative vertebra, the fourth, instead of discussing all of these. This vertebra from the Skhūl V series is shown in Fig. 68 B, set between two modern representative vertebrae, a Bushman's and a Sikh's. The fossil specimen resembles that of the Bushman in many points, especially in the slenderness of its formation. The Sikh represents the robust type. How greatly the Skhūl vertebra differs from the Sikh example in the dimensions of vertebral canal, in massiveness of the neural arch and of the spinous process will be realized from the measurements given in Table XXV (p. 111). Perhaps the greatest difference lies in the development of the spinous process. The Skhūl and the Bushman specimens have the same pin-shaped spinous processes, only that in the Bushman it is very short. In the Sikh it is not only long but wide (Fig. 68 C). The lengths of the spinous processes of the various cervical vertebrae are given in Table XXV, line 10 (p. 111), and their form is clearly shown in Fig. 64. The tip of the spinous process remains undivided throughout the cervical series in Skhūl V; it is also so in the Bushman and in the chimpanzee. All the processes are bifid in the Sikh, as they are in those of most civilized peoples.

When we add up the height of the bodies of the third to seventh cervical vertebrae (Table XXV, line 5, p. 111) we find the total for Skhūl V to be 55·5 mm., as against 50 mm. in the Bushman and 65·1 mm. in the Sikh, the latter approximating the mean measurement for European males (68·4 mm.). Here again we find evidence of the remarkable shortness of the cervical segment of the vertebral column of Skhūl V. Allowance has to be made for the crushed state of the bodies of the vertebrae in our specimen; yet, when this has been done, the very real shortness of the neck cannot be explained away. Martin's observation that the cervical part of the vertebral column is of 'slender build' in Europeans (Martin, 1928, vol. ii, p. 1082) is noteworthy, for certainly this is the case in the cervical vertebrae of Skhūl V. This characteristic must be taken into account in estimating the probable relationship of the Skhūl type to the modern European.

THE DORSAL VERTEBRAE

The dorsal region of the vertebral column has been preserved in three individuals: Tabūn I, Skhūl IV, and Skhūl V. Details relating to the parts of the vertebrae recovered are given in the sections devoted to each of these individuals.

Tabūn I.

The preserved portions of the vertebral column of the Tabūn woman are shown in Fig. 69. The illustration is a reproduction of a sketch-plan made during the excavation

of the vertebrae and ribs from the block in which this part of the skeleton was embedded. The vertebral series extends from the third to the tenth. There is only half of the body of the third; those for the fourth, fifth, sixth, and seventh are nearly intact though the vertebral arches have been broken and pressed against the bodies. The body of the eighth was in a state of disintegration and its margins were difficult to distinguish from the surrounding soil.

We found, when describing the lower limb bones of the Tabūn woman, that the corresponding bones of a Bushman offered the best parallel amongst living races. From the length of their thigh bones it was inferred that they were of about equal stature (p. 67), both being just over five feet. We have compared the measurements of the bodies and the laminae of their dorsal vertebrae in Table XXVI (p. 112). The total height of the bodies of the six vertebrae (3–8) in the Tabūn series is 100·6 mm., giving a mean of 16·7 mm. per vertebra. The total is 100·8 mm. in the Bushman, giving a mean body height of 16·8 mm. We infer, therefore, that in their total height, the dorsal region was approximately similar (Bushman, 210 mm.; Tabūn I, *c.* 200 mm.). It is probable that the lower dorsal vertebrae in the Tabūn woman were more compressed than those of the Bushman, for we shall find that this is the case in the Skhūl vertebrae. Boule found a relatively low height of body in the La Chapelle man. Amongst human races the dorsal part of the column forms a very constant proportion to the whole, namely about 53 per cent. If we take the combined dorsal body heights of the Tabūn column to be 200 mm., then we may infer that the height of the pre-sacral spine had been about 377 mm. This is much less than in the average European woman but greater than in the average Senoi woman (Martin, 1928, vol. ii, p. 1078).

The individual widths of the dorsal vertebrae are given in Table XXVI (p. 112). The mean width of these in the Tabūn woman was 21·8 mm., as against 21·6 mm. in the Bushman, but the dorso-ventral diameters of the Bushman are the greater, the mean being 20·1 mm., as against 18·1 mm. in Tabūn. If we take the width diameter as our standard, it being the more constant, in the Tabūn woman the height of body is 76·6 per cent. of the width. It is almost the same in the Bushman, 77·7 per cent., but the ratio of dorso-ventral diameter to height is different, being 83 per cent. in the Tabūn vertebrae (Nos. 3–8) and 93 per cent. in the Bushman. We measured the corresponding series of dorsal vertebrae in a chimpanzee; the height ratio is low (72·1 per cent.), but the dorso-ventral ratio is rather high (88·2 per cent.). The short dorso-ventral diameter in the Tabūn woman cannot be counted an anthropoid feature, rather the opposite.

There is another feature of the bodies of the Tabūn dorsal vertebrae which is non-anthropoid. The dorsal aspect of the body which forms the ventral portion of the vertebral canal is remarkably flat. In the corresponding vertebrae of the chimpanzee the posterior surface of the body is concave in a transverse direction; this is so in the Bushman and in modern man generally. The Skhūl vertebrae likewise show this concavity. This flatness of the dorsal aspect of the bodies of the Tabūn vertebrae is a specialization. Another unusual circumstance of this aspect of the vertebra is the absence of the large openings for the vertebral veins, which are found in anthropoid and modern races.

The laminae are preserved in the upper four (D, 3, 4, 5, and 6) of the Tabūn dorsal vertebrae, so we have been able to compare them with those of the Bushman. The Tabūn laminae, as will be seen from Table XXVI (p. 112), are wider, the mean width being

16·3 mm., against 14·8 mm. for the Bushman. The Skhūl vertebrae have wide and thick laminae also (Table XXVII, p. 112), as compared with those of native races.

None of the spinous processes of Tabūn I are preserved save at the root where they spring from the laminar arch. Spinous processes in man and ape are flattened from side to side, with a sharp upper border which runs well on to the laminar arch. In the Tabūn woman the upper dorsal spines have a low dome-like origin from the laminar arch. They were compressed in a cranio-caudal direction, being less in their dorso-ventral diameter than in the Bushman.

There is the terminal part of a detached spinous process. It is massive and has features which leave little doubt that it was part of the twelfth dorsal vertebra. It is longer, stronger, and more massive than the same process in the Bushman. The tip of the spine in the latter has a cranio-caudal diameter of 13 mm., its width 6 mm. The respective measurements for the Tabūn spine are 14 mm. and 12 mm., indicating powerful spinal muscles.

There is a dearth of data relating to the dorsal region of the vertebral column of Neanderthal man. Only the imperfect body of one dorsal vertebra was found at Krapina but its proportions are very remarkable. Its height is only 17·5 mm. and its width 29·5 mm., giving a height index of 59·3 per cent. as against 76·6 per cent. for Tabūn I and 77·7 per cent. for the upper dorsals of the Bushman. Boule found a part of all the dorsal vertebrae of the La Chapelle skeleton; unfortunately most of them were fragmentary and the seventh was not represented. We shall refer to his observations when considering the Skhūl vertebrae. Meanwhile we may note how shallow were the bodies of the upper three dorsal vertebrae in La Chapelle. Their mean height was 15·7 mm. This is the height which we found in the third dorsal vertebra of the Tabūn woman. A feature of the Neanderthal vertebra is its shallowness, and this character is shared to a certain extent by Tabūn I.

Skhūl IV.

Our vertebral series (dorsal) begins in this man with the eleventh dorsal, followed by the twelfth. We know so little of the vertebrae of Neanderthal man that these are welcome additions, more especially as they come from a region of the human spine which changes from the dorsal to the lumbar type. The only Neanderthal vertebra of this region is the tenth dorsal of La Chapelle figured by Boule (Boule, 1911, Pl. VI, Figs. 3, 3*a*). We infer from his illustration that the height of the body was about 20 mm., whereas the average European male has one which is 3·2 mm. higher. From the little we know we infer that the bodies of the vertebrae of Neanderthal man were remarkably low in height of body.

Measurements of the two dorsal vertebrae of Skhūl IV are given in Table XXVII (p. 111), and with them are the corresponding measurements of an Australian (estimated stature 1,700 mm., or 67 inches) and of a Sikh (estimated stature 1,666 mm., or *c.* 65·5 inches). From his femur we estimate that Skhūl IV was taller than either (estimated mean femoral stature 1,738 mm. or 68·4 inches). The height of the body of the tenth dorsal vertebra in these two modern men was almost the same, 21 mm. and 21·4 mm. This is distinctly more than the corresponding measurement in the La Chapelle specimen (20 mm.). The body height of the eleventh vertebra in both the modern specimens was 22 mm., in Skhūl IV, 21·3 mm. Both had the same height in the twelfth, 24 mm., but

in Skhūl IV it was only 21 mm. When we consider his stature, the twelfth of Skhūl IV is very low, which we must consider to be a Neanderthal feature. In Skhūl V, who had a longer femur than Skhūl IV, parts of the eleventh and twelfth dorsal vertebrae are preserved and from the remnants we infer that both had low bodies, our estimate being 20·5 mm. for each of them. Apparently in this character, height of vertebral body, as in other spinal features the Skhūl men possess traits which point to a relationship with the Neanderthals of Europe. Yet, for aught we know, this may prove to be a character of all types of ancient man.

A lateral view of the two dorsal vertebrae of Skhūl IV is given in Fig. 70 B, set beside the corresponding spinal segments of an Australian. The differences in their spinous processes, the levers on which the spinal muscles act, are at once apparent. Measurements are given in Table XXVII (p. 112). The spinous process of the eleventh is not only exceptional in its length and strength, but also in the fact that its characters resemble those of a tenth dorsal. The twelfth is also long and strong, but in its shape recalls the process of an eleventh rather than of a twelfth, which normally assumes lumbar characters, as is the case in the Australian (Fig. 70 A). Another fact is also noteworthy: the eleventh dorsal spinous process in modern man shows an incipient bifid condition at its tip; inferior bifidity is well marked in the twelfth. Skhūl IV resembles modern man in this condition, whereas in Skhūl V the apices are divided to a less degree. It will be noted later that in rib form we find Skhūl V to show Neanderthal traits, Skhūl IV those of modern man.

An examination of the table of measurements will bring out many other points of difference. For example, in the measurements of the total dorso-ventral diameter of each vertebra, the Skhūl vertebrae exceed all those with which we have compared them. Figs. 70 A, B also show that the pedicles are longer, and the intervertebral foramina for exit of the spinal nerves are larger in the modern than in the ancient spinal column.

Another point of interest may be mentioned here. The tip of the eleventh transverse process in modern man (sometimes the tip of the tenth, too), has no articular facet for the rib. The costal facet is present in the eleventh transverse process of Skhūl V and is extensive; we suspect that it was also present in the eleventh of Skhūl IV (Fig. 70 B, *c*), but the area is eroded and the condition of costal contact uncertain. The pedicles of the Skhūl vertebrae are very strong and their laminae wide (Table XXVII, p. 112).

Another view, the cranial aspect of the eleventh dorsal vertebra of Skhūl IV, is given in Fig. 70 B′. It will be seen that the vertebral canal is wide and capacious (Table XXVII, p. 112), a character which Boule observed in the La Chapelle male. It is to be noted that the part of the wall formed by the body of the vertebra (Fig. 70 B′) is concave from side to side, as in modern vertebrae, not flat as in Tabūn I.

It is evident from Fig. 70 A′, B′, and also from Table XXVII (p. 112), that the upper aspects of the bodies of the dorsal vertebrae of Skhūl IV show certain unexpected features. The bodies of the vertebrae of Neanderthal man are low but wide; here they are low and narrow. The mean body width of the two vertebrae of Skhūl IV is 33·5 mm., as against 38·6 mm. in the Sikh, and 32·8 mm. in the Australian. The mean dorso-ventral diameters of the same specimens are respectively 26·7 mm., 30·7 mm., and 25·4 mm. The dorso-ventral diameter is 80 per cent. of the width in Skhūl IV, in the Sikh it is almost the same, 79·5 per cent., while it is 77·4 per cent. in the Australian. The bodies of the Skhūl

vertebrae, like those of modern man, are absolutely and relatively narrow; those of Neanderthal man absolutely and relatively wide.

Skhūl V.

The state of the dorsal part of the vertebral column of this tall man, after it had been freed from the block of breccia in which it was embedded, but with the ribs still attached, is shown in Pl. IX. The laminar arches and spinous processes (more or less complete) are preserved from the first to the twelfth. Nos. 1 and 2 are attached to the cervical vertebrae and are shown in Fig. 64 A. The arch of the third is detached and separate. Nos. 4, 5, 6, 7, and 8 (Pl. IX) follow in perfect sequence; the spinous processes of 9 and 10 are bent towards the left; the body of the eleventh has been rotated so that its right side is presented dorsally, and the twelfth has fallen with its spine forwards, so that its caudal aspect is presented dorsally. The bodies have unfortunately vanished save in the cases of the first, second, eleventh, and twelfth and the latter are not entire. We have already mentioned that these bodies are low and therefore Neanderthaloid, which is in keeping with what we find in the cervical vertebrae and also in the conformation of the ribs. The articular processes in the cervical region were more horizontal in their position than is the case in the cervical vertebrae of modern man and this character is found to continue throughout the dorsal region. Two other points have been mentioned in connexion with the dorsal region of Skhūl V: the presence of a wide articular facet on the transverse process for rib 11, the absence of bifurcation at the tip of the spinous process of the tenth dorsal, and the lesser degree of division of the tips of Dorsal 11 and 12. As will be seen from Table XXVIII (p. 113), these processes were long and strong.

LENGTH OF DORSAL PART OF SPINAL COLUMN

Is it possible in the case of Skhūl V to determine the original length of the spine, having only the laminar arches and the articular processes? We believe that a reasonable estimate can be made. The laminae and the articular processes are locked in an extended position. We measured on the fossil specimen the distance from the proximal border of the fourth laminar arch to the distal margin of the eighth: the length was 78 mm. We articulated the corresponding dorsal vertebrae of an Australian in the same manner, made a similar measurement and found it to be 73 mm. In the Sikh this measurement was 91·5 mm. Provisionally it seemed to indicate that the dorsal column of Skhūl V was longer than that of the Australian but correspondingly shorter than that of the Sikh. We found, however, that the laminae were relatively narrow in the Australian compared to the height of the corresponding vertebral body; in the Sikh an opposite relation held. So we carried our analysis farther. We took the sum of the individual laminar widths, from Dorsal 1 to Dorsal 12, and found it to be 222·6 mm., making allowances for overlapping in the few cases where this was necessary. That gave a mean laminar width of 18·5 mm. The total for the Australian was 190·8 mm., giving a mean for each lamina of 15·5 mm. In the Sikh the figures were 237·2 mm. and 19·7 mm. respectively. The bodies of the dorsal vertebrae in the Australian had a combined height of 227 mm., with a mean height of 18·9 mm. The total was almost the same in the Sikh (228·4 mm.) with a mean of 19·0 mm. Thus, while the bodies had almost the same height in these two individuals, the laminae of the Sikh were 4·2 mm. wider on the average. Now in their dimensions

and conformation the laminae of Skhūl V resemble those of the Sikh, so it is on him rather than on the Australian that we must base our estimate of 225 mm. It is clear that Skhūl V was a man with a short body when his great length of thigh is taken into consideration. It will be remembered how compressed was the cervical portion of his spine; this compression also affected his dorsal region and, probably, his lumbar region as well. It is likely that shortness of vertebral column will prove to be a feature of Palaeoanthropic man. His spine was certainly short compared to that of the average male European. Aeby (Martin, 1928, vol. ii, p. 1078) found that the bodies of the dorsal vertebrae in the average male European had a total height of 243 mm., giving a mean height for each body of 20·2 mm. In the Sikh, who served as a standard of comparison for Skhūl V, the total was 228·4 mm., the mean 19·0 mm. This serves to bring home the excessive shortness of the spinal column in Skhūl V.

A few points on the conformation of the laminar arches and the spinous processes require attention. We have described the dome-shaped root of the spinous process in Tabūn I (p. 99); there is a similar conformation in Skhūl V. In only a few vertebrae could measurements be made of the intact spinous or transverse processes (Table XXVIII, p. 113). Spine 10 is fortunately intact; its length as measured by us was 34·5 mm., in the Sikh it was 36 mm., in the Australian 32 mm. It is stouter in Skhūl V than it is in the other two males and it is set less obliquely than in them. The upper border of the spine makes an angle with the line joining the tips of the articular processes (left upper and lower) of about 40°. This angle in the Sikh is only 33°, in the Australian 38°. The Skhūl spinous process is bent less downwards than in modern man. The tip of spine 10 in modern man shows a slight degree of bifurcation; there is none in Skhūl V. There is a trace of bifidity in spine 11 of Skhūl V but less than in modern spines and the same feature holds for the spine of the twelfth dorsal. Other characters of the spines of the Dorsal eleventh and twelfth have been touched upon in the description of these vertebrae in Skhūl IV (p. 100).

The width of the vertebral grooves, from the tip of one transverse process to the tip of the other, can be measured in the tenth Dorsal of Skhūl V. This distance is 55 mm., 4 mm. less than in the Sikh but 5 mm. more than in the Australian. The vertebral grooves are relatively shallow owing to the transverse processes being bent dorsally to a less degree than in modern man. The vertebral canal in the twelfth dorsal was low and wide, its dorso-ventral diameter being only 14·5 mm., its width 20 mm., almost the same measurements which obtain at the same level in the spinal column of the Sikh.

LUMBAR REGION OF THE VERTEBRAL COLUMN

We have representative parts of this region from three of the Skhūl people: the laminar arches of the tall man, Skhūl V (Fig. 71 B); bodies of four vertebrae and some fragments of the arches of Skhūl IV (Fig. 72 B); two bodies (Lumbar 4, 5) from the spine of the woman, Skhūl VII. These parts are particularly precious for several reasons. There is first of all the paucity of material, for we know the lumbar vertebrae of only one Neanderthal individual, La Chapelle. There is another reason: the lumbar region of the spine of early man, like his cervical region, may be expected to show primitive features which have become modified to give the mobility of spine found in modern man. The lumbar vertebrae, like the ulna and radius in their adaptation to the finer movements of pronation

and supination, have evidently been modified in modern man in connexion with the elaborate and intricate balancing movements of the body which are executed in the lumbar part of the back. We have found certain primitive features in the lumbar vertebrae of the Mount Carmel people, which, however, do not signify that they were less adapted to the upright posture than is modern man, only that their loins were less mobile than those of modern man. We shall give our measurements and observations in some detail for, imperfect as these are, it may be some time before such specimens are again brought to light.

We have included in Tables XXIX and XXX (pp. 113–14) measurements of all the lumbar vertebrae, but we shall make our survey by taking up each individual in turn, beginning with Skhūl V. We have given in Fig. 71 B a drawing of the lumbar region of the spine of Skhūl V, viewed from behind and set beside the corresponding vertebrae of the Sikh. The lumbar vertebrae of Skhūl V were exposed *in situ*, the second, third, and fourth being joined together in their natural relationships, save that at the time of burial the lumbar part of the spine was bent somewhat ventrally, exposing wide interlaminar spaces. The laminar arches of Lumbar 1 and 2 were broken and came away separately; in the drawing they have been replaced in their normal relationships. Only the spinous process of Lumbar 1 is complete. All of the others are imperfect as are the articular processes; the latter are not completely absent.

As this is the first opportunity there has been of estimating both the total length of the lumbar part of the vertebral column and of its individual parts in a mid-Pleistocene man, we have taken some pains in making our estimates. In Skhūl V we have to base them on the dimensions of the laminar arches, for the bodies have perished. The lumbar vertebrae of Skhūl V, measured by calipers on the actual specimen from the proximal end of the upper articular process of Lumbar 1 to the distal end of the lower articular process of Lumbar 5 gives a length of 143 mm. The same measurement in the Sikh is 158 mm. The actual height of the bodies of the five lumbar vertebrae in the Sikh is 124·1 mm. By making a corresponding reduction for Skhūl V the height of the bodies of the lumbar vertebrae is 112·4 mm. Both of these are very low figures; 143 mm. is the estimate of lumbar body height for the average European.

The height of the bodies of the cervical vertebrae (C. 3–7) in Skhūl V are 55·5 mm. We have estimated the height of the dorsal region to be 225 mm. and of the lumbar region to be 112·4 mm. The total height of the bony components of the spinal column is 392·9 mm. and if we add the heights of the atlas and axis (35 mm.) the result is 427·9 mm. For the Sikh the comparable figures are 417·6 mm. and 456·6 mm. In European males the sum of the vertical diameters of the vertebral bodies (minus atlas and axis) is 455 mm. on the average. In the living spine about three-fourths of the height is formed by the bony bodies and the remaining fourth by the intervertebral disks. To obtain the actual height of the pre-sacral column in Skhūl V we must add 155·9 mm., giving a living height of 583·8 mm. A corresponding addition for the Sikh gives 609·3 mm. as a result. The average pre-sacral height in European males is about 619 mm. This absolute difference becomes the more remarkable when we remember that the stature of this Skhūl man, estimated from his femur, is 136 mm. greater than the average stature of modern European men. In his reconstruction of La Chapelle man Boule gives the pre-sacral vertebral column a length nearly equal to that of the average male European. One has to suppose, to obtain

such a length, that the intervertebral disks were relatively thicker than in modern man. In the present instance, even if we have made an under-estimate, and we do not think we have, Skhūl V had a surprisingly short trunk length when one takes into consideration the lengths of his femur and humerus. The lumbar region usually forms about 32 per cent. of the combined heights of the vertebral bodies (excluding the atlas and axis) in the modern spine. In Skhūl V the lumbar segment of the column is only 28·5 per cent. of the whole, but the dorsal portion was relatively long, 57+ per cent., in contrast to the European figure of 53·4 per cent. The Palestinian neck, on the other hand, is short: 14 per cent. of the whole column height as against 15·3 per cent. for European males.

A surprising feature of the view of the lumbar region presented in Fig. 71 B is the extent of the interlaminar spaces. This space is open only between Lumbar 4 and 5 in the Sikh spine (Fig. 71 A), due to the horizontal direction of the two lower spinous processes. These spaces were open between all the lumbar vertebrae in Skhūl V, a condition found in the vertebrae of primitive races such as the Australians and also in the lumbar regions of the anthropoid apes. The openness of these spaces in Skhūl V is partly due to a flexure of the spine; but, making all allowances on this score, the spaces are exceptionally wide, indicating backwardly directed spinous processes and an absence of lumbar curvature. The lumbar part of the spine was straight, as in Australians.

The lengths of the spinous processes are given in Table XXX (p. 114). The process of Lumbar 1 of Skhūl V was the only one quite intact and in length and strength it was somewhat less than in the Sikh, but its direction was more horizontal.

The widths and thickness of the laminar plates are given in Table XXX (p. 114). The mean width is the same for Skhūl V as for the Sikh (20·6 mm.). The upper laminae are wider in the Sikh, but there is a marked reduction in the widths of those of Lumbar 4 and 5. The mean width for the Australian is only 17·6 mm.

As is well known, the two lower articular processes of Lumbar 5 in human skeletons are set widely apart, as are the corresponding processes on the base of the sacrum into which they fit (Fig. 71 A). The trans-articular measurement is 52 mm. in Skhūl V, 54 mm. in the Sikh, and only 45 mm. in the Australian. The width was almost 60 mm. in La Chapelle man.[1] The corresponding width between the outer margins of the lower processes of Lumbar 3 in Skhūl V was 37·5 mm.; in the Sikh, 37 mm.; in the Australian, 25·5 mm., and in La Chapelle, 39 mm. The lumbar vertebrae of La Chapelle in their width dimensions exceed those of Skhūl V, in which respect the Skhūl type stands nearer to the modern. The upper articular processes are less concave transversely, the lower less convex, than the lumbar vertebrae of modern man. Boule has made a similar observation on the vertebrae of the La Chapelle specimen. Only one transverse process is preserved, the right of the fifth lumbar. It is very strong. The bases of the other transverse processes show that they were more robust than is the case in modern man.

It is of interest to turn to the vertebral column of the Cromagnons at this point. We have seen that in length of limb bones and many other characters there are many resemblances between the Cromagnons and the Skhūl type. Verneau gives no measurements of the vertebrae but he has published in Plate I of his famous monograph (Verneau, 1906, Pl. I) an excellent photograph of the man from the Grottes des Enfants with the bones

[1] All vertebral measurements relating to the La Chapelle skeleton have been made on the photographs published by Boule.

placed in their natural positions. There is no scale[1] attached, but as we know the projected length of the right femur (526 mm.) we can use this in attempting to estimate the lengths of the various parts of the skeleton, including the spinal column. In the photograph this man has a stature of *c.* 1,900 mm. (74·8 inches). The length of his pre-sacral vertebral column is short for such a stature, measuring 580–5 mm. Skhūl V, with a pre-sacral height of 583·8 mm., had about the same spine length, though relative to his femur it was slightly longer. Both the Skhūl men and the Cromagnons were absolutely shorter in the back than modern Europeans, and the difference in proportion to the stature was large.

We shall consider more fully the dimensions of the lumbar vertebrae and the shape of their bodies when we describe the vertebral column of Skhūl IV. Meanwhile it may be said that the combined anterior heights of the lumbar bodies in the Grottes des Enfants man is *c.* 150 mm., giving an estimated mean vertebral body height of 30 mm., as against means[2] of 24·2 mm. for Skhūl IV and 25·3 mm. for the Sikh. If we allow for the inter-vertebral disks, then the height of the lumbar column in this specimen of the tall Cromagnons was probably 175 mm. (perhaps 180 mm. would be nearer the mark). Taking the smaller figure, however, we find that it represents about 30 per cent. of the total spine height, approximately the same as in the Skhūl men.

The lumbar vertebrae of the Cromagnon man were wide; that of the third vertebra has a mean width of *c.* 55 mm. as against a proximal width in Skhūl IV of 47 mm. The estimated mean height of the Cromagnon vertebral body, 30 mm., represents 54–5 per cent. of the width; this is rather more than in Skhūl IV where the corresponding proportion is about 51 per cent.

Skhūl IV.

The parts of the lumbar spine which were recovered from Skhūl IV are shown in Fig. 72 B. His estimated stature, it will be remembered, is 1,738 mm. (68·4 inches). The lumbar column as reconstructed in Fig. 72 B is 140 mm. long and that of the Sikh, which has been set beside it (Fig. 74 A), is 151 mm.[3] We find here again, as in Skhūl V, a marked shortening in the height of the lumbar column. The estimates for the two men are almost the same, 138 mm. in the case of Skhūl V, 140 mm. in Skhūl IV. We know only the two lowest dorsal vertebrae of Skhūl IV but they were also of a low height (p. 100) and confirm our belief that we are dealing with a short vertebral column and that it was a feature of both the Skhūl men.

A comparison with the lumbar vertebrae of La Chapelle is instructive. Boule gives the heights of the dorsal aspects of the bodies of Lumbar 1, 2, 4, 5, Lumbar 3 not being recovered. The total height of the four vertebrae was 107·3 mm., giving a mean height for each of 25·4 mm. If we add the mean amount for the missing bone, the total height must have been at least 132 mm. We have the bodies of four vertebrae of Skhūl IV, Lumbar 2, 3, 4, 5. Their individual heights and other dimensions are given in Table XXIX (p. 113). The total height of the dorsal aspect of the four extant specimens is 95·7 mm.,

[1] The reduction is approximately 3/25ths.

[2] Mean values of the dorsal and ventral heights.

[3] The height of the Sikh's spine given when considering Skhūl V was 124·1 mm.; that measurement represents the combined heights of the bodies. The height given here is that measured along the ventral curvature.

giving a mean body height of 23·9, 1·5 mm. less than in La Chapelle man. If we add the mean amount for the first lumbar, the total is 119·6 mm. as against the estimated 132 mm. for La Chapelle. In our standard skeleton, that of the Sikh, the total posterior vertebral body height was 129·4 mm., the mean posterior body height of each bone, 25·8 mm., only 0·4 mm. more than in La Chapelle. The total posterior height of the five lumbar vertebrae in an Australian skeleton was 117·6 mm., giving a mean height of 23·5 mm. for each vertebra, 0·4 mm. less than in Skhūl IV. The anterior vertical height of the five lumbar vertebrae in male Europeans is on the average about 143·6 mm. (Martin, 1928, vol. ii, p. 1078), giving an individual vertebral mean of 28·7 mm. Usually the anterior lumbar height somewhat exceeds the posterior height but the comparison will make clear how short the lumbar region was in ancient man and particularly the men of Mount Carmel.

Lumbar Curvature.

Our observations leave no doubt as to the shortness of the spinal column, and particularly of the lumbar part, in the Skhūl people. Boule inferred that the lumbar region in the European Neanderthals was straight; the evidence at our disposal points to the same condition in the Skhūl people. Prof. D. J. Cunningham (1886) introduced a method for estimating lumbar curvature. It is based upon the ratio which the posterior height of the bodies of the lumbar vertebrae forms with their anterior height. If the spinal curvature was determined wholly by the shapes of the bony bodies, then it would be an admirable method but much of the curvature is determined by the shape of the intervertebral disks and the tension of the intervertebral ligaments. For example, in the Sikh's vertebral column (Fig. 72 A) the total posterior height of the lumbar vertebrae is 129·4 mm., the anterior, 124·1 mm. The posterior height stands to the anterior as 104·2 : 100. As will be seen from Table XXIX (p. 113), in which the anterior and posterior heights are given, all the lumbar vertebrae of the Sikh are higher posteriorly than anteriorly. If the shape of vertebral bodies determined the amount of curvature, then this spine should have bent forward at the loins. In Fig. 72 the articular processes are in normal contact and the spine shows a certain degree of lumbar curvature. Lumbar 4 and 5 are higher in front than behind in an Australian skeleton used for comparison, a common condition in modern man. The total anterior height in the Australian was 124·2 mm., the posterior height 117·6 mm., the posterior being 94·7 per cent. of the anterior and indicating a well developed lumbar curvature. In Skhūl IV the total anterior height of the four extant vertebrae is 98·7 mm., the posterior, 95·7 mm.; the ratio being 97·4 per cent. This is a modern degree of curvature. The anterior predominance in Skhūl IV (Table XXIX, p. 113) is confined to the last lumbar vertebra, the index for the upper three being 103. In the Skhūl woman (VII) too, the lowest and last of the lumbar vertebrae has an anterior predominance in height. Boule noted that this same characteristic was confined to the fifth lumbarin La Chapelle.

Another feature of the lumbar spine, brought out in Fig. 72 B, is the length, strength, and horizontal position of the spinous processes of the lumbar vertebrae. The spinous processes in the chimpanzee diminish in length and strength from first to fifth, whereas in the human spine the spinous process of the third is often the longest and strongest. The first was the shortest of the series in Skhūl IV. In modern man the spinous processes

of Lumbar 4 and 5 are short, stout, and are directed backwards in a more or less horizontal position; this also appears to have been the case in Neanderthal man (Fig. 72 C). The processes in all the lumbar vertebrae of Skhūl IV were directed more horizontally than in modern races. Table XXX (p. 114) and Fig. 72 B show that the spinous processes formed long and, therefore, powerful levers for the spinal muscles. Their length helps to make up the great dorso-ventral diameter of the whole vertebra (Fig. 72). It includes all that lies between the ventral surface of the body of the vertebra and the tip of the spinous process, the measurement being made parallel to the cranial surface of the body of the vertebra. The dorso-ventral diameter of Lumbar 4 of Skhūl IV may be compared with the fourth lumbar of La Chapelle man in Fig. 72 C. The total diameter in La Chapelle is 81·5 mm., of which the antero-posterior diameter of the vertebral body forms 49 per cent. In the modern spine (Fig. 72 A) the total is only 75 mm., the body forming 48 per cent., only a little less than in La Chapelle. The total in the fourth lumbar of an Australian is only 72 mm., the thickness of the vertebral body forming 45·8 per cent. of the whole, there being a relative predominance in length of the spinous process. The total dorso-ventral diameter was at least 82 mm. in Skhūl IV, of which the vertebral body made up only 41–2 per cent., so great was the predominance of the spinous process. Although La Chapelle man, like Skhūl IV, had a vertebra with a large dorso-ventral diameter, the great length in the latter was due to the predominance of the spine and in the former to the great front to back thickness of the body of the vertebra (cf. also Fig. 73).

Another aspect of the vertebra of Skhūl IV is shown in Fig. 73. A variety of measurements relating to the height and width of the body and its dorso-ventral diameter are given in Tables XXIX and XXX (pp. 113–14), but these fail to bring out the peculiar shape of these bones in Skhūl IV. The bodies of the vertebrae seen from above or below have a cordiform shape, a conformation which may be seen in the vertebrae of Australians. This cordiform shape is due, in part at least, to the posterior part of the body being concave from side to side. Indeed, the vertebral canal must have been as represented in Fig. 73 B, of a wide oval form.

The relative proportions of the bodies of the lumbar vertebrae of Skhūl IV, and presumably those of Skhūl V, are peculiar. This is made apparent in the following manner. We have combined the two height measurements to get a mean body height and have done the same with the width measurements and the dorso-ventral diameter. We have combined the measurements of all the vertebrae to give an ideal lumbar vertebra, and have taken the mean width as the chief diameter with which to compare the other diameters. The width of the mean lumbar vertebra of the Sikh is 46·4 mm.; the height, 25·3 mm., is 54·5 per cent. of the width and the dorso-ventral diameter, 31·6 mm., is 70·2 per cent. of the width. The mean lumbar vertebra of an Australian, representing another modern type, has a width of 44·5 mm., almost 2 mm. less than in the Sikh. Its height, 24·1 mm., represents 54·1 per cent. of the width, almost the same ratio as in the Sikh, and its dorso-ventral diameter, 31·5 mm., is 70·8 per cent. of the width, again almost the same proportion as in the Sikh. Owing to Boule's reluctance to make a record of measurements, we are forced to base our estimates of the size and proportions of the lumbar vertebrae of La Chapelle on the photographs which he gives, particularly upon that of the second lumbar. This representative vertebra is wide, more so than in our specimens of modern man. Its width is *c.* 52 mm.; its height, *c.* 27 mm., is 71–72 per cent. of the width, a

relatively low vertebra. The dorso-ventral diameter, *c.* 33 mm., represents 63–4 per cent. of the width, against 70 per cent. for our modern specimens. The lumbar vertebra of La Chapelle was absolutely wide, but relatively low and short from back to front.

Turning now to the lumbar vertebrae of Skhūl IV, the width of the mean vertebra is 45·2 mm., intermediate to those of the Sikh and the Australian and, therefore, modern in its measurement. Its height, 24·2 mm., almost the same as in the Australian, is 53·5 per cent. of the width. This is somewhat lower than in the modern lumbar vertebra but higher than in the Neanderthalian type of La Chapelle. Its dorso-ventral diameter is 29·8 mm., distinctly less than in the modern examples and is only 65·9 per cent. of the width, a ratio which stands between those of the modern and of the La Chapelle type. In short, the bodies of the lumbar vertebrae of Skhūl IV are intermediate in character and bridge the gap between the modern and the Neanderthalian types, but they stand nearer to the former than to the latter.

The bodies of the lumbar vertebrae of the Krapina people were small; indeed, all the measurements indicate that the Neanderthalians of Krapina were undersized both in stature and strength. Kramberger gives measurements of three lumbar vertebrae, the mean width of them being only 42·3 mm., the mean height, 21·2 mm., only 50 per cent. of the width and therefore relatively lower than even the low La Chapelle vertebrae. The dorso-ventral diameter, 29·2 mm., is 69 per cent. of the width, a ratio found in modern vertebrae. The outstanding features of the Krapina lumbar vertebrae are their small size and low height.

Skhūl VII.

Only the bodies of two of the lumbar vertebrae (L. 4 and 5) of this woman are well preserved; there is an incomplete spinous process from the lumbar series and what is probably a lumbar transverse process. A drawing of the cranial aspect of the body of the fourth lumbar is given in Fig. 73 C; the measurements will be found in Table XXIX (p. 113). The vertebrae of this woman are more oval in shape than are those of Skhūl IV (Fig. 73 B, C). There is evidence that the dorsal surface of the body was concave from side to side but to a less degree than in Skhūl IV. L 4 is higher behind than in front, L 5 is the opposite. The mean width of the two vertebrae is 43·6 mm.; the mean height, 22·8 mm., is 52·2 per cent. of the width, making them both relatively and absolutely low bodied. The mean dorso-ventral diameter, 29·5 mm., is 67·6 per cent. of the width and approaches the modern type in this proportion. On the evidence provided by these two vertebrae we infer that this Skhūl woman, like the Skhūl men, was short in spine and trunk.

Summary.

We make no apologies for the length to which we have carried our description and discussion of the vertebrae. Though the material is incomplete, yet it is both new and important, providing us with the basis for a knowledge of a part of the body which has undergone great changes in the course of human evolution.

Skhūl V is the only individual from which we have a representation of all parts of the vertebral column. In Skhūl IV we have the lower dorsal and the lumbar vertebrae and a part of the sacrum. There are two lumbar bodies and a fragment of the sacrum of the

woman, Skhūl VII. The inference to be drawn is that the vertebral column was remarkably short in all three individuals, especially when the length of the femur and of the other limb bones is taken into account. So far as our knowledge goes, and it is meagre in amount, the Neanderthalians of Europe had short spines but not to the degree shown by the Skhūl people. Shortness affected all regions of the spine in the latter folk, especially in the neck and the loins.

The Skhūl vertebrae show certain primitive features in the length and horizontal direction of the spinous processes of the cervical and lumbar segments of the vertebral column. They resemble the Neanderthalians of Europe in this, and no doubt all early primitive races of mankind, for we are dealing with generalized primitive features. The bodies of the vertebrae are less specialized than those of the Neanderthalians. There is no feature in the vertebral column of the Skhūl people that might not be readily transformed in the course of evolution into the vertebral column of modern man. This appears to be true also of the vertebral column of the Tabūn woman as far as we know it, for our positive knowledge regarding it is confined to the dorsal region.

Note.—When correcting the proofs of this work, there appeared a paper by Professor Wood-Jones (*Journ. Anat.*, 1938, lxxii, 411) on the cervical vertebrae of the Australian aborigines. The peculiar features noted by him in the aborigines are present in the Mount Carmel cervical vertebrae, and also in those of the Bushman.

*Table XXIII.** VERTEBRAE (THE ATLAS)

	Skhūl V	*Bushman*	*Tabūn I*	*Sikh*	*La Chapelle*†	*Krapina*†
Diameters of vertebral canal:						
sagittal‡	38·0	36·5	..	31·0	..	..
maximum transverse	30·0	32·0	..	28·0	31·6	..
Distance between the tuberosities for attachment of transverse ligament	22·0	15·3	..	24·0	..	..
Maximum vertebral diameters:						
antero-posterior§	47·8	44·3	..	49·5	..	..
transverse‖	52·0	50·8	..	57·6	50·2	..
Maximum height of lateral mass¶	17·6	15·3	..	24·0	18·3	17·0
Upper articular facet:						
antero-posterior length	28·3	18·1	..	26·0	28·5	..
maximum width	10·5	19·2	..	10·2	12·0	..
Lower articular facet:						
antero-posterior length	20·5	18·8	..	19·5	18·0	..
maximum width	14·0	13·0	..	15·5	16·8	..
Anterior tubercle:						
maximum vertical diameter	10·5	7·3	9·2	12·0	9·0	12·5
minimum antero-posterior diameter	6·4	4·6	3·3	7·2	5·2	5·8
Posterior tubercle:						
vertical diameter**	9·0	6·5	10·0	12·0	..	..
minimum antero-posterior diameter	4·5	4·6	4·0	11·0	..	..
Lateral segment, posterior arch: ††						
vertical diameter	7·6	4·5	7·5	10·5	..	..
medio-lateral diameter	5·2	3·2	4·6	8·0	..	..

* There are no wholly intact fossil vertebrae. In this and in Tables XXIV–XXX we have not attempted to discriminate between the degrees of certainty in making the measurements, except those (placed in parenthesis) which are open to considerable latitude of interpretation.

† Figures for the La Chapelle atlas are based upon measurement of the drawing (Fig. 65 B); the Krapina figures from Kramberger (1906).

‡ Measured from the internal upper margin of the anterior arch to the internal upper margin of the posterior arch, in the sagittal plane.

§ Maximum antero-posterior diameter along the sagittal plane.

‖ Maximum diameter between the superior lateral margins of the facets for articulation with the occipital condyles.

¶ Maximum height measured from the upper lateral articular margin to the lower lateral articular margin.

** Taken parallel to the internal or neural surface.

†† Diameters taken at a point midway between the groove for the vertebral artery and the posterior tubercle.

Table XXIV. VERTEBRAE (THE AXIS)

	Skhūl V	*Tabūn I*	*Bushman*	*Sikh*	*Krapina**
Diameters upper articular surface:					
maximum antero-posterior	20·5	..	19·3	20·0	..
maximum transverse†	13·5	..	15·3	16·0	..
Diameters of lower articular surface:					
maximum antero-posterior	13·0	11·0	11·0	12·5	(11·0)
maximum transverse	9·2	9·5	8·0	11·3	(10·0)
Spine length‡	10·4	..	12·5	23·5	..
Diameters of lamina:§					
cranio-caudal	11·0	7·0	9·0	13·0	(12·0)
medio-lateral (thickness)	4·6	4·2	2·8	7·0	..
Angle formed by lower articular surface with lower margin of laminar arch	163°	160°	128°	130°	(113°)
Total vertebral height M 1*a*	30·0	..	32·7	39·2	32·6
Height of odontoid‖	12·5	..	13·1	16·5	(15·0)
Body, lower surface:					
width (transverse diameter)	20·5	..	17·4	19·0	17·7
dorso-ventral diameter	16·0	..	14·0	16·8	..
Vertebral canal:					
antero-posterior diameter	24·6	..	21·0	22·0	(18·0)
maximum transverse diameter	26·0	..	26·0	23·0	(25·0)
Total dorso-ventral diameter¶	44·5	..	43·5	47·5	41·9
Width between articular surfaces for the atlas**	44·2	..	42·4	47·5	45·3

* Figures in parenthesis are made from the photographs; other figures are means of 3 adult bones. After Kramberger (1906).

† Taken at right angles to the maximum antero-posterior diameter.

‡ Measured from the mid-point on the dorsal margin of the arch to the tip of the spine.

§ Taken at a point on the lamina midway between the spine and the pedicle.

‖ Taken from the tip to the upper margin of the articulation for the atlas.

¶ Taken from the anterior inferior margin of the body to the tip of the spine, the vertebra being placed upon the measuring board resting on its lower surface.

** Taken between the most distant points on the lateral margins of the articular surfaces for the atlas.

Table XXV. THIRD—SEVENTH CERVICAL VERTEBRAE

	Skhūl V		*Bushman*	*Sikh*	*Skhūl V*			*Krapina**			*Bushman*	*Sikh*
	3	4	4	4	5	6	7	5	6	7	7	7
Total diameters:												
maximum dorso-ventral†	(35·0)	41·4	32·4	45·7	52·2	58·8	61·0	..	..	..	56·0	62·0
maximum transverse‡	45·2	47·0	44·5	52·0	48·8	48·0	43·0	..	..	..	50·0	49·5
Diameters vertebral canal:												
dorso-ventral†	21·0	18·0	14·0	13·5	18·5	..	..	..	..	..	16·0	14·5
transverse†	25·0	24·5	23·0	23·0	25·5	24·0	..	..	..	..	23·0	23·0
Height of body M 2	10·5	10·0	9·5	12·0	10·0	(13·0)	(12·0)	9·0	9·0	9·5	11·7	14·5
Diameters of body:												
maximum transverse M 8	22·4	21·0	18·7	21·0	25·0	24·5	..	18·6	20·0	21·0	22·5	29·0
dorso-ventral M 5	..	15·0	14·0	14·8	18·0	18·7	21·0	13·6	13·6	14·3	13·2	15·0
Diameters of lamina:												
cranio-caudal†	7·5	9·0	9·0	12·5	10·0	14·5	12·5	..	..	..	12·6	18·2
medio-lateral†	1·5	1·8	1·5	4·0	2·0	2·5	..	..	..	..	3·5	6·8
Spine length†	7·0	13·0	6·5	26·5	17·5	24·8	26·0	..	..	..	27·0	31·4

* Measurements after Kramberger (1906).

† Taken in the same manner as for the axis (cf. Table XXIV).

‡ Taken between the most lateral points of the inferior articular processes on the vertebral arch.

Table XXVI. DORSAL VERTEBRAE

	Dorsal 3		*Dorsal 4*		*Dorsal 5*		*Dorsal 6*		*Dorsal 7*		*Dorsal 8*	
	Tabūn I	*Bushman*	*Tabūn I*	*Bushman*	*Tabūn I*	*Bushman*	*Tabūn I*	*Bushman*	*Tabūn I*	*Bushman*	*Tabūn I*	*Bushman*
Body:												
anterior height M 1	15·7	16·4	17·1	15·9	16·1	17·0	16·4	17·0	19·3	17·5	16·0	17·0
transverse diameter* M 9	21·0	22·2	21·3	21·0	21·5	20·5	23·6	21·5	20·5	20·9	..	23·6
cranial aspect sagittal diameter M 4	15·2	16·3	18·6	17·7	20·0	19·2	20·5	21·4	18·5	22·2	16·0	23·6
Lamina: †												
cranio-caudal diameter	14·4	14·0	16·0	15·2	16·3	15·0	18·5	15·0	..	16·0	..	15·8
dorso-ventral diameter	7·0	5·0	6·2	4·6	6·0	5·0	5·5	5·0	..	5·0	..	5·0

* Taken immediately below the level of the pedicles.
† Taken immediately lateral to the base of the spine.

Table XXVII. DORSAL VERTEBRAE

	Dorsal 11			*Dorsal 12*		
	Skhūl IV	*Sikh*	*Australian*	*Skhūl IV*	*Sikh*	*Australian*
Body:						
anterior height M 1	21·3	22·5	22·0	21·0	23·8	24·3
transverse diameter M 9	33·0	38·0	31·6	(34·0)	39·3	34·0
cranial aspect sagittal diameter M 4	25·0	30·4	24·8	28·4	31·0	26·0
Lamina: *						
cranio-caudal diameter	20·0	23·0	19·3	20·6	24·0	19·5
dorso-ventral diameter	6·0	6·0	6·0	6·3	6·0	7·2
Vertebral canal:						
minimum dorso-ventral diameter†	17·0	13·0	16·5	16·5	16·0	18·0
maximum transverse diameter‡	(18·0)	17·0	18·0	(18·0)	17·0	20·0
Spinous process:						
length§	35·0	30·0	27·5	35·0	30·0	25·5
cranio-caudal diameter of tip‖	11·8	10·5	9·5	12·5	17·0	17·5
maximum width of tip	10·0	7·0	8·8	11·2	12·0	9·3
Maximum vertebral dorso-ventral diameter ¶	69·0	65·5	63·6	73·0	68·5	66·5
Bi-articular diameter**	33·5	36·0	37·5	37·0	43·0	37·5
Transverse process:						
length††	20·0	18·0	19·0	(11·0)	19·4	16·5
cranio-caudal diameter‡‡	9·5	12·0	8·0	8·0	12·5	8·5
Minimum cranio-caudal diameter of pedicle	16·0	17·2	14·8	(15·5)	16·4	14·0

* Table XXVI, note †.
† Projected sagittal diameter, cranial aspect.
‡ Taken at right angles to the preceding.
§ Taken parallel to the cranial border, from the angle of the laminar arch to the most distant point of the tip.
‖ Taken at right angles to the cranial border of the spinous process.
¶ Taken with calipers parallel to the cranial aspect of the body in the sagittal plane.
** Maximum distance between the cranial margin of the upper and the caudal margin of the lower articular process.
†† Taken with calipers from the tip to the nearest point of the facet for the rib.
‡‡ Taken at the mid-point of the length.

Table XXVIII. DORSAL VERTEBRAE (SKHŪL V)

	Skhūl V											
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*
Lamina:*												
cranio-caudal diameter	14·5	15·2	16·0	15·8	17·0	18·4	20·0	18·0	20·2	21·0	19·5	(23·0)
thickness	..	6·2	6·0	5·5	5·6	7·0	7·2	7·0	6·8	7·0	5·8	6·4
Spinous process: †												
length	(28·0)	..	..	(30·0)	25·0+	27·0+	28·0+	27·0+	32·0+	34·5	33·0	30·0
dorso-ventral diameter of root‡ . .	17·5	13·4	..	..	..	..	12·8	11·0	15·0	15·3	15·0	..
Bi-articular diameter§ .	26·0	28·0	33·0	..	28·0	27·0	(28·5)	32·0	36·0	34·2	33·0	33·0+
Pedicle:												
cranio-caudal diameter	11·0	9·0	11·0	..	..	..	..	..	..	13·5	16·0	15·5
medio-lateral diameter	..	6·5	5·4	..	..	..	..	..	..	6·5	9·2	10·0
Length transverse process‖ . . .	..	..	..	..	..	..	25·0+	20·0+	22·0	18·0+	18·0	..

* Taken at right angles to the caudal border, midway between the articular process and the root of the spinous process. Usually the cranial margin of the lamina was overlapped by the caudal margin of the lamina above, the overlap amounting to about 2 mm., but this amount has not been included in the stated values. The thickness of the lamina was measured at right angles to the cranio-caudal diameter, at the same point.

† Table XXVII, note §.

‡ Taken at the base of the process as it emerges from the laminar arch.

§ Table XXVII, note **.

‖ Table XXVII, note ††.

Table XXIX. LUMBAR VERTEBRAE

	Lumbar 1				*Lumbar 2*				*Lumbar 3*			
	Skhūl IV	*Skhūl V*	*Sikh*	*Australian*	*Skhūl IV*	*Skhūl V*	*Sikh*	*Australian*	*Skhūl IV*	*Skhūl V*	*Sikh*	*Australian*
Body height:												
anterior M 1	..	..	25·0	23·5	23·7	..	24·8	25·0	25·5	..	25·0	25·2
posterior M 2	..	..	27·2	25·4	24·5	..	27·5	26·0	25·5	..	26·5	25·2
Body width:												
proximal M 7 . . .	(36·0)	..	41·0	40·0	47·5	..	44·6	43·5	47·0	..	48·5	46·0
middle M 9	..	..	36·0	36·2	43·5	..	40·0	37·5	30·0	..	42·3	39·0
distal M 8	..	..	45·0	44·5	49·2	..	48·0	46·5	(42·5)	..	51·6	49·0
Dorso-ventral diameter of body:												
proximal M 4 . . .	(28·0)	..	30·5	28·0	29·2	..	31·2	30·0	31·5	..	30·0	32·5
distal M 5	..	..	30·6	30·0	(30·0)	..	31·0	31·6	29·5	..	31·2	32·0
Bi-articular diameter† . .	..	..	47·0	42·0	..	46·0	47·6	47·0	..	46·0	43·5	43·5

	Lumbar 4					*Lumbar 5*					
	Skhūl IV	*Skhūl V*	*Skhūl VII*	*Sikh*	*Australian*	*Skhūl IV*	*Skhūl V*	*Skhūl VII*	*Sikh*	*Australian*	*Krapina**
Body height:											
anterior M 1 . . .	22·0	..	22·5	24·5	25·5	27·0	..	24·0	24·8	25·0	(21·2)
posterior M 2 . .	23·2	..	23·7	26·0	22·0	22·5	..	21·0	22·2	19·0	..
Body width:											
proximal M 7 . .	44·5	..	49·0	51·8	47·0	49·0	..	(44·0)	52·5	47·5	(42·3)
middle M 9 . .	38·5	..	42·5	46·0	40·0	41·5	..	40·0	47·0	43·2	..
distal M 8 . . .	(45·0)	..	..	53·0	50·0	50·0	..	(43·0)	50·5	48·5	..
Dorso-ventral diameter of body:											
proximal M 4 . .	28·0	..	28·5	31·0	31·5	30·0	..	30·0	34·0	34·0	(29·0)
distal M 5 . . .	28·0	..	30·6	33·0	33·0	32·0	..	29·0	34·5	32·5	..
Bi-articular diameter† .	..	(39·0)	..	41·0	38·7	..	33·0	..	40·0	35·0	..

* Mean values of measurements made by Kramberger on three lumbar vertebrae, positions unassigned.

† Table XXVII, note ††.

Table XXX. LUMBAR VERTEBRAE

	Lumbar 1				*Lumbar 2*				*Lumbar 3*			
	Skhūl IV	*Skhūl V*	*Sikh*	*Australian*	*Skhūl IV*	*Skhūl V*	*Sikh*	*Australian*	*Skhūl IV*	*Skhūl V*	*Sikh*	*Australian*
Lamina:*												
width	..	20·5	23·4	18·7	..	20·5	25·0	20·0	..	24·0	24·0	20·0
thickness	..	6·2	6·5	6·0	..	6·8	6·4	7·8	..	7·0	6·2	7·0
Spinous process:												
length†	..	26·5	31·5	27·0	(25·0)	..	31·5	29·0	..	..	31·0	30·0
cranio-caudal diameter of tip‡	23·4	19·5	23·5	17·8	15·5	..	19·6	24·0	..	..	20·0	25·5
width of tip	15·0	(11·0)	10·2	10·0	(10·5)	..	10·5	10·0	..	..	12·0	11·4
Pedicle:												
cranio-caudal diameter	..	17·7	15·0	14·0	..	..	15·0	13·0	..	16·2	16·2	13·5
medio-lateral diameter	..	8·8	8·5	5·8	..	..	9·5	6·2	..	10·0	11·0	8·0
Transverse process:												
length§	..	..	26·0	19·0	..	..	33·0	25·0	..	..	36·0	30·5
cranio-caudal diameter‖	..	..	8·0	6·2	..	..	10·5	9·5	..	..	11·0	10·0

	Lumbar 4					*Lumbar 5*			
	Skhūl IV	*Skhūl V*	*Skhūl VII*	*Sikh*	*Australian*	*Skhūl IV*	*Skhūl V*	*Sikh*	*Australian*
Lamina:*									
width	19·0	(19·0)	..	17·0	18·0	17·7	(19·0)	14·0	11·0
thickness	6·3	5·4	..	7·0	6·0	5·8	7·0	6·5	5·0
Spinous process:									
length†	36·0	..	..	28·4	27·4	31·6	..	20·0	24·0
cranio-caudal diameter of tip‡	22·0	..	..	11·0	19·5	18·2	..	15·0	12·0
width of tip	11·0	..	..	8·0	8·0	7·8	..	9·0	7·4
Pedicle:									
cranio-caudal diameter	13·0	..	12·2	17·0	14·0	..	21·5	31·0	15·4
medio-lateral diameter	10·0	..	..	10·0	7·0	..	10·0	8·6	7·0
Transverse process:									
length§	..	..	..	32·0	26·0	..	27·0	31·0	26·0
cranio-caudal diameter‖	..	..	..	7·5	6·0	..	(12·0)	6·8	10·4

* Table XXVIII, note *.
† Table XXVII, note §.
‡ Table XXVII, note ‖.
§ Taken from the tip of the process to the medial (neural) margin of the pedicle, on the cranial aspect.
‖ Taken cranio-caudally at the mid-point between the base and apex of the free part of the process.

FIG. 64. CERVICAL VERTEBRAE, RIGHT LATERAL ASPECT. A, Skhūl V (the first and second dorsal vertebrae are fixed to the lower two cervicals); B, Bushman (with the upper three dorsal vertebrae also shown); C, La Chapelle (the fifth cervical to the third dorsal vertebrae only are shown. Enlarged from a photograph after Boule). *a*, laminar arch of axis; *b*, lateral articular column; *c*, transverse process of the fourth cervical vertebra; *d*, transverse process, with costal articulation, of the first dorsal vertebra; *e*, root of the transverse process of the second dorsal vertebra. The spines and bodies of the vertebrae are numbered.

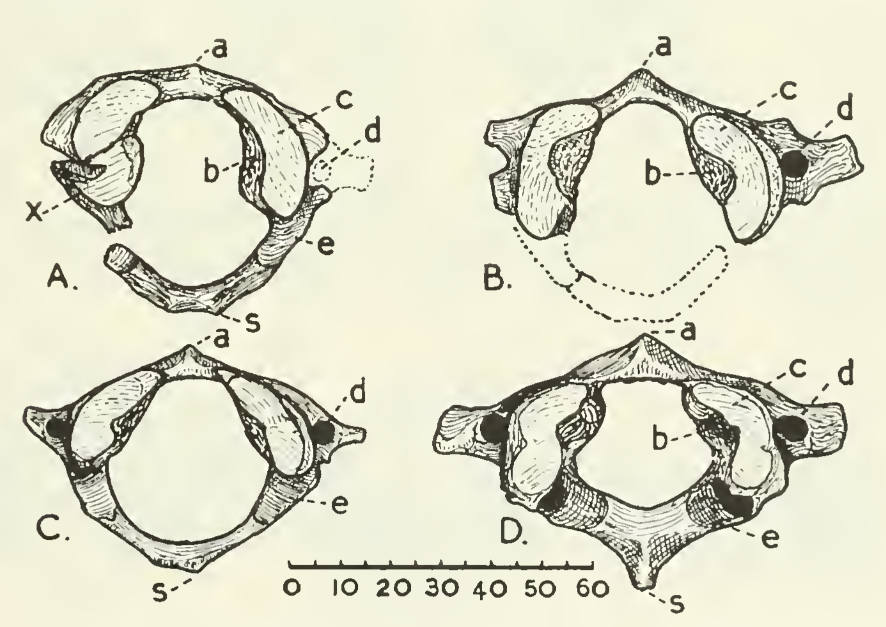


FIG. 65. CRANIAL ASPECT OF THE ATLAS. A, Skhūl V; B, La Chapelle (enlarged and adapted from a photograph after Boule); C, Bushman; D, Sikh. *x*, detached part of the left lateral mass in the Skhūl atlas; *a*, anterior arch; *b*, rough area for attachment of the transverse ligament; *c*, articular surface for occipital condyle; *d*, foramen for vertebral artery in transverse process; *e*, groove for vertebral artery (enclosed in the Sikh atlas). The stippled outline shown in the figure of the La Chapelle atlas is a reverse of the posterior arch of the Skhūl atlas.

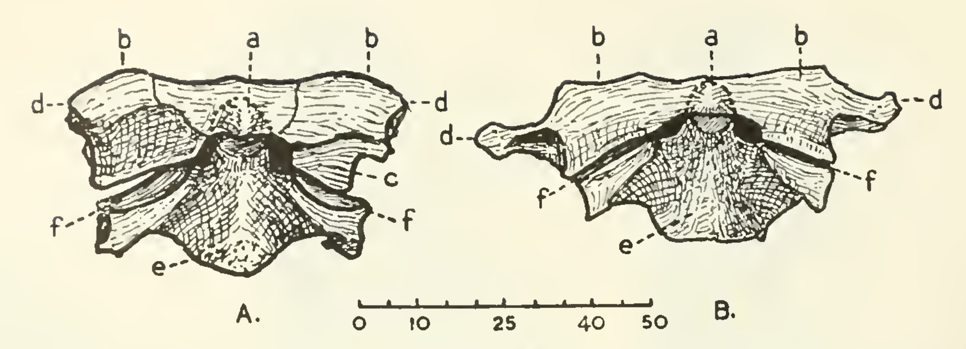


Fig. 66. Anterior Aspect of the Articulated Atlas and Axis. A, Skhūl V; B, Bushman. *a*, tubercle of the anterior arch of the atlas (the outline of the odontoid process is stippled around it); *b*, articular lateral mass; *c*, displaced fragment of the Skhūl atlas; *d*, transverse process (the root only remains in the Skhūl specimen); *e*, body of the axis; *f*, articular surface for the atlas on the upper aspect of the axis.

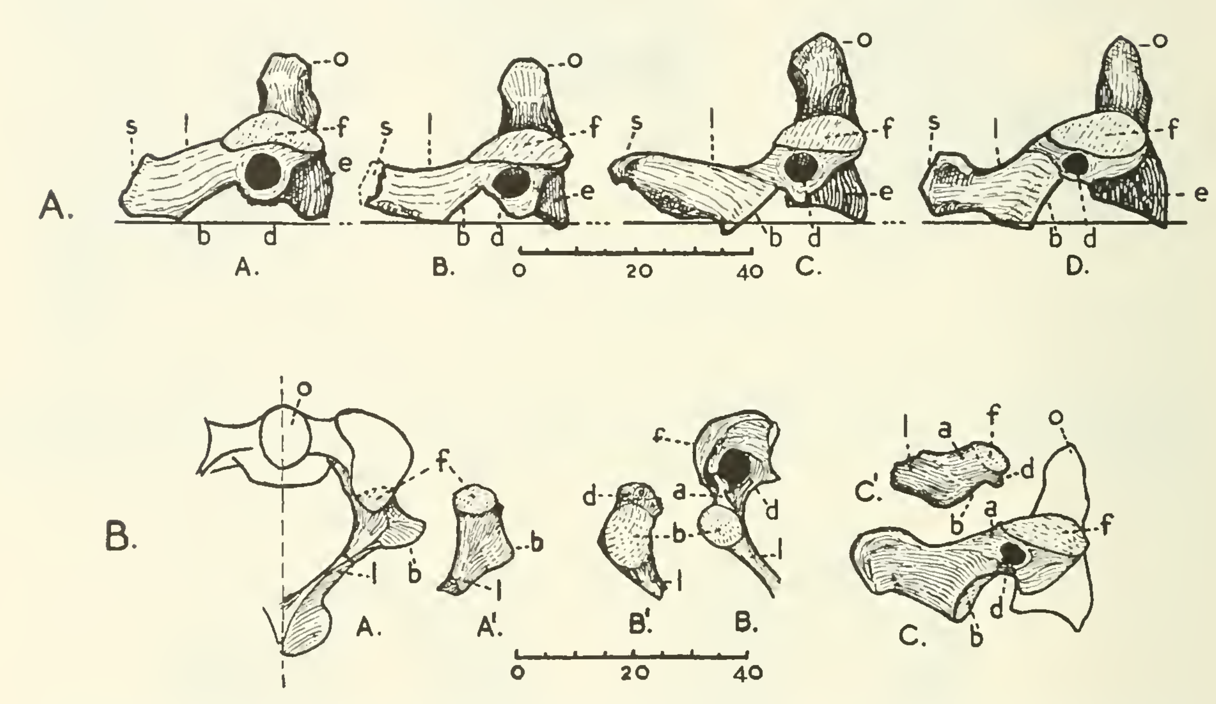


Fig. 67. The Axis. A, upper series. Right lateral aspect. A, Skhūl V; B, Krapina (from a photograph after Kramberger); C, Australian; D, Bushman. B, lower series. Cranial aspect of: A, Bushman; A′, Tabūn I. Caudal aspect of axis: B, Bushman; B′, Fragment of Tabūn I. Lateral aspect of axis: C, Bushman; C′, Tabūn I. *o*, odontoid process; *f*, upper articular surface; *e*, body; *b*, lower articular surface; *d*, foramen for vertebral artery; *l*, lamina of arch; *a*, pedicle of arch; *s*, spinous process.

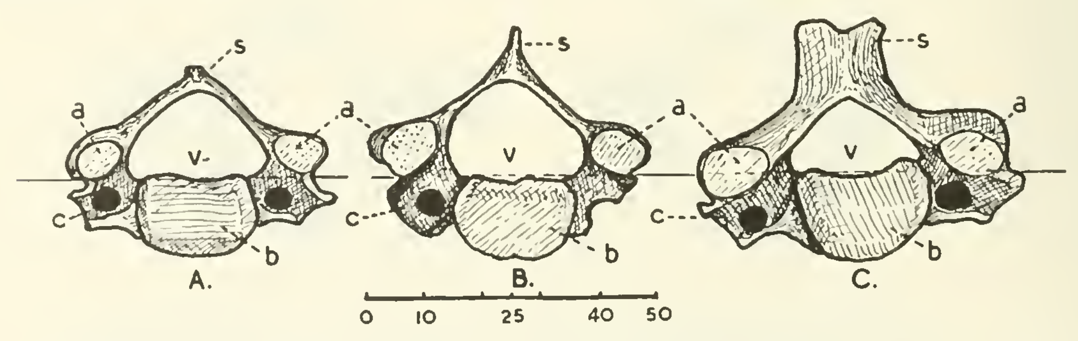


Fig. 68. The Fourth Cervical Vertebra, Cranial Aspect. A, Bushman; B, Skhūl V; C, Sikh. *a*, upper articular process; *b*, body; *c*, transverse process perforated by the canal for the vertebral artery; *v*, vertebral canal; *s*, spinous process.

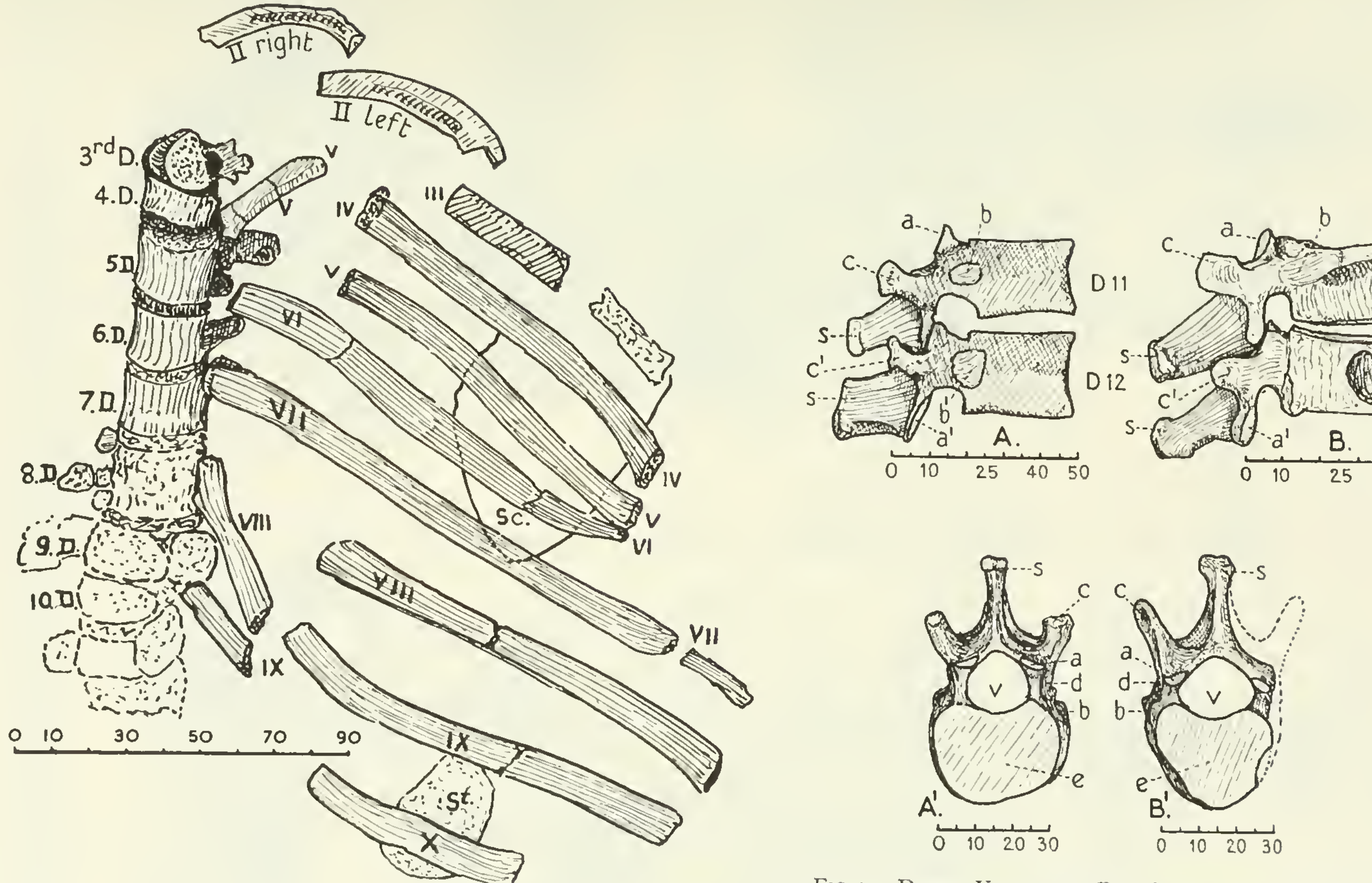


Fig. 69. Sketch-plan of the Vertebral and Costal Parts of Tabūn I as exposed in situ. The bodies of the vertebrae distal to the seventh were difficult to distinguish from the matrix, becoming indistinguishable at the tenth. Dorsal vertebrae are numbered in arabic figures, ribs in Roman figures. *st.*, stone under tenth rib, leaving a deep imprint upon the bone; *sc.*, lower angle of the left scapula.

Fig. 70. Dorsal Vertebrae. Dorsal vertebrae 11 and 12, right lateral aspect. A, Australian (male); B, Skhūl IV (the right and left aspects have been combined, the lateral surface of the bodies being preserved only on the left side). *a*, upper articular process (D 11); *a′*, lower articular process (D 12); *b*, *b′*, costal facets; *c*, *c′*, transverse processes; *s*, spinous process. Dorsal vertebra 11, cranial aspect. A′, Australian (male); B′, Skhūl IV. *d*, pedicle of arch; *e*, body; *v*, vertebral canal; other letters as above.

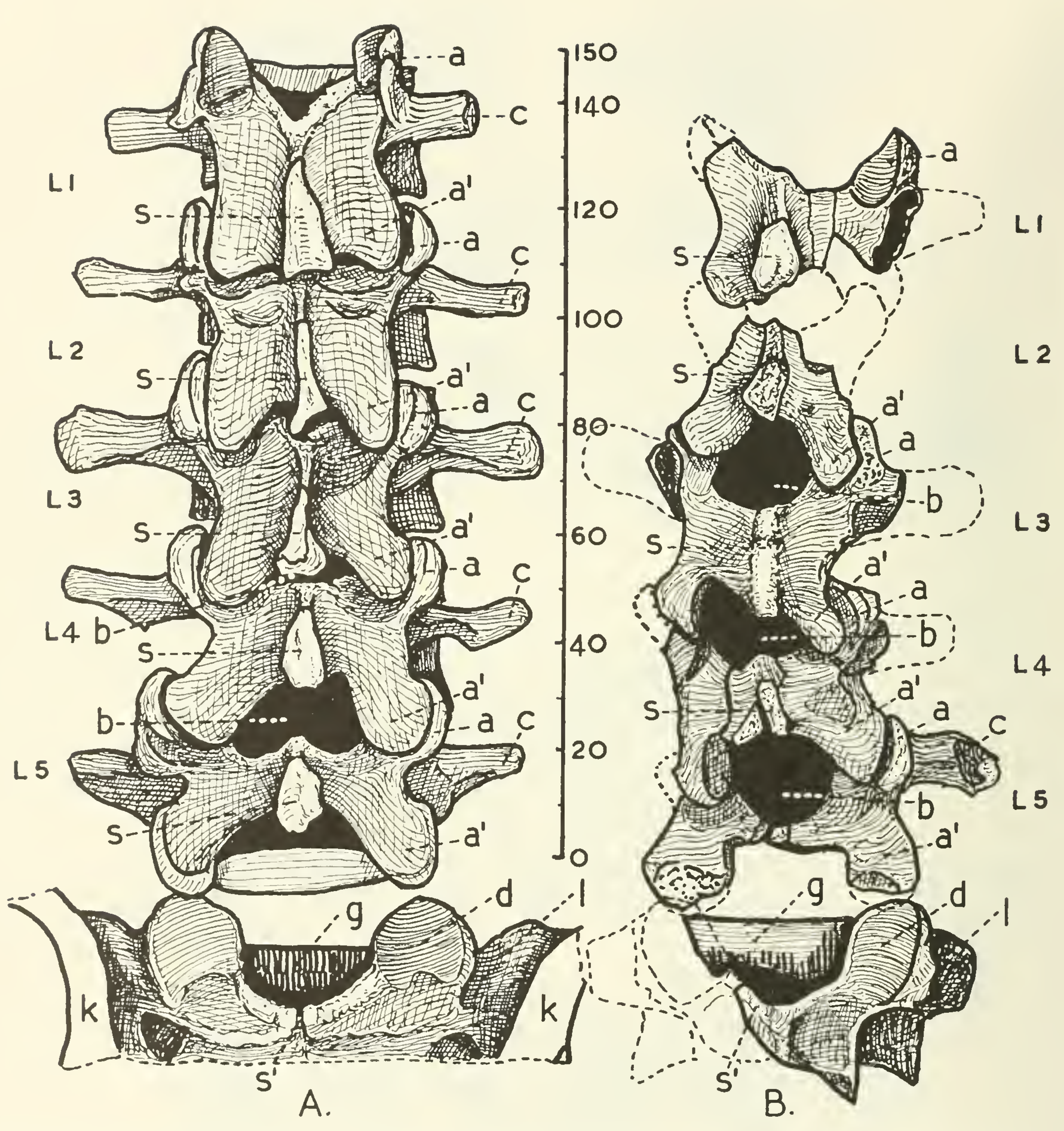


Fig. 71. Dorsal Aspect of the Lumbar Vertebrae (Articulated). A, Sikh; B, Skhūl V. *a*, upper articular process; *a′*, lower articular process; *b*, interlaminar space; *c*, transverse process (absent in Skhūl V except in L 5); *d*, upper articular process of sacrum; *g*, body of the first sacral vertebra; *k*, crest of the ilium; *l*, lateral mass of sacrum; *s*, spinous process; *s′*, spinous process of S 1.

Fig. 72. Lumbar Vertebrae, Right Lateral Aspect. A, Sikh; B, Skhūl IV; C, L 4 and L 5 of La Chapelle (from a photograph after Boule). *e*, body of vertebra; other letters as in Fig. 71.

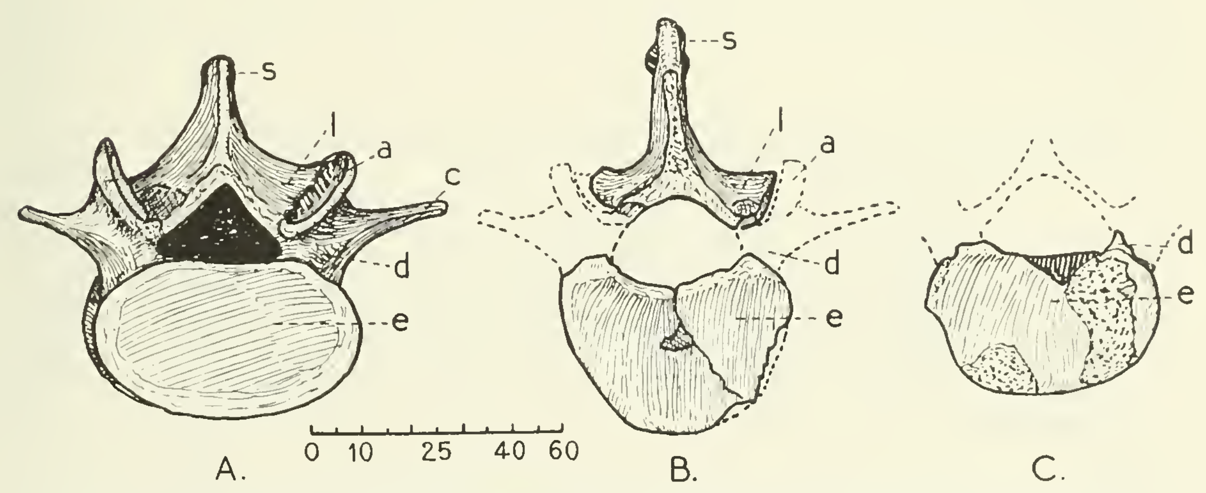


Fig. 73. Fourth Lumbar Vertebra, Cranial Aspect. A, Sikh; B, Skhūl IV; C, Skhūl VII. *a*, upper articular process; *c*, transverse process; *d*, pedicle; *e*, body of vertebra; *l*, lamina; *s*, spinous process.



CHAPTER VIII

RESPIRATORY SYSTEM

THE RIBS (Pl. X; Figs. 74–84)

THE following list represents the material at our disposal:

Tabūn I.

First pair—both missing.

Second pair—right: ventral end; left: lacks head, neck, and tuberosity, otherwise complete; length[1] 155 mm.

Third pair—right: fragment of ventral end; left: lacks dorsal and ventral extremities; length along curvature 254 mm.

Fourth pair—right: two fragments; left: intact from the tubercle almost to the ventral end; length along curvature 275 mm.

Fifth pair—right: head, neck, and tuberosity; left: from the neck to about the mid-point of the body; length along curvature 165 mm.

Sixth pair—right: two fragments, 230 mm.; left: head and ventral end only are lacking; length 295 mm.

Seventh pair—right: two fragments; left: complete except for head; length 304 mm. A rib of exceptional strength.

Eighth pair—right: fragment; left: head and neck only are lacking; length 283 mm.

Ninth pair—right: middle and ventral parts; left: complete from the angle to the ventral end; length 220 mm.

Tenth pair—right: missing; left: from the angle almost to the ventral end; length 185 mm.

Eleventh pair—right: fragment; left: dorsal and ventral extremities lacking; length 156 mm.

Twelfth pair—missing.

Skhūl IV.

First pair—right: missing; left: head, neck, and tuberosity lacking; length along greater curvature 82 mm.

Second pair—right: lateral and ventral part; length 127 mm.; left: missing.

Third pair—right: lateral and ventral part; length 177 mm.; left: missing.

Fourth pair—right: lateral and ventral part; length 220 mm.; left: missing.

Fifth pair—right: lateral and ventral part; length 186 mm.; left: missing.

Sixth pair—right: almost complete except for small defect at ventral end; length 327 mm.; left: five fragments.

Seventh pair—right: lateral and ventral part; length 195 mm.; left: lateral and ventral part; length 240 mm.

[1] Except in the cases of the tenth, eleventh, and twelfth ribs the length was measured along the greater curvature from the dorsal border of the tuberosity to the ventral end of the ribs.

Eighth pair—right: head, neck, and tuberosity with lateral part; length 273 mm.; left: complete; length 308 mm.

Ninth pair—right: missing; left: almost complete; length 250 mm.

Tenth pair—right: two fragments but almost complete; length 202 mm.; left: almost complete; length 225 mm.

Eleventh pair—right: lateral part with head and ventral end lacking; length 126 mm.; left: complete; length 197 mm.

Twelfth pair—right: fragment; left: two fragments; combined length 77 mm.

Skhūl V.

First pair—missing.

Second pair—right: missing; left: lateral fragment; length 125 mm.; crushed fragment, probably the dorsal end.

Third pair—right: missing; left: lateral part, from neck nearly to ventral end; length 183 mm.

Fourth pair—right: a lateral (152 mm.) and a dorsal fragment (82 mm.); length 234 mm.; left: ventral end lacking; length 245 mm.

Fifth pair—right: dorsal fragment; left: ventral part lacking; length 253 mm.

Sixth pair—right: dorsal segment only; left: ventral part lacking; length 267 mm.

Seventh pair—right: missing; left: head and ventral part lacking; length 220 mm.

Eighth pair—right: fragment; left: head, neck, and ventral part lacking; length 202 mm.

Ninth pair—right: ventral fragment; left: head, neck, and ventral part lacking; length 190 mm.

Tenth pair—right: dorsal fragment; left: head and ventral part lacking; length 158 mm.

Eleventh pair—missing.

Twelfth pair—missing.

The left ribs, beginning with the fourth and ending with the tenth were cleaned but left in the positions they occupied *in situ* (Plate IX c, d). The dorsal ends are still in articulation with their respective vertebrae. The ventral ends are defective in all.

Skhūl VI.

There are two fragments only of the ribs, the chief one being the sternal end of the first left rib. This measures 63 mm. There is also a fragment of the body of a third or fourth measuring 43 mm. from a point a little ventral to the angle. Both of the fragments suggest that this man had big and stout ribs.

Skhūl VII.

There are six costal fragments, the longest measuring 64 mm. and representing the ventral end of an eighth or ninth left rib. The diameters at a point 50 mm. from the ventral end are $6{\cdot}8 \times 10$ mm.

Skhūl IX.

There are parts of five ribs of the left side. These are: two fragments of a sixth (?) measuring together 62 mm.; the neck and tubercle and part of the lateral and ventral

portions of the shaft of an eighth; about half of the ninth rib from a point just lateral to the tuberosity to within *c.* 80 mm. of the ventral end (168 mm.); a similar proportion of the tenth rib (109 mm.), and two fragments of the dorsal part of the shaft of the eleventh rib.

Skhūl I.

The ribs of this child are described in Chapter XX.

First Rib.

We have only one large fragment, part of the first left rib of Skhūl IV, which is shown in Fig. 74 B, where it is compared with the corresponding bone of a Sikh, and with a tracing made from a photograph of a specimen found at Krapina. The large Skhūl specimen closely resembles that of the Sikh in all its markings (Fig. 74 A, B); the scalene tubercle, for the scalenus anterior muscle, is more developed in the fossil specimen. The curvature of the dorsal portion is considerably less in the fossil specimen. Kramberger, the only observer who has had the opportunity of studying the first rib of Neanderthal man (fragments of seven specimens having been found at Krapina), declares that the first is the most distinctive of the Neanderthal costal series and that its chief feature is the straightness of its shaft, whereas in modern races the shaft is bent inwards. This is at once made apparent when the Krapina rib is compared with a modern specimen (Fig. 74 C and A). Unfortunately the dorsal extremity of the Skhūl rib is missing, but by superimposing the corresponding parts of the Sikh and the Krapina specimens, one sees that the Skhūl rib is intermediate in its curvature.

We shall see that this greater curvature, or greater bending of the costal head and neck in modern man, is due to the fact that his vertebral column occupies a more forward position in the thorax than in ancient man, who in this respect resembles the gorilla. We may look upon the Skhūl rib as marking a movement towards the modern condition.

It will be seen from our table of measurements (Table XXXI, p. 127) that those for the Skhūl rib exceed those of the Sikh and very greatly exceed those found at Krapina. The Krapina Neanderthalians were a small and slenderly made folk. The ventral end of the first rib of Skhūl VI is similar to that of Skhūl IV in shape and dimensions; at a distance 10 mm. dorsal to the extremity the diameters are $7{\cdot}5 \times 15{\cdot}5$ mm.

Second Rib.

We have given measurements in Table XXXII (p. 128) of our three specimens of the second rib, Tabūn I, Skhūl IV, Skhūl V. The Tabūn specimen is complete ventral to the tubercle, the Skhūl specimens being less complete. We have given three illustrations (Figs. 75, 76, 77). So far as we can learn only one specimen has been described and figured, a dorsal fragment of a right rib by Kramberger. The characters of this rib seem to us to throw light upon the racial nature of the Palestinians. In Fig. 75 are views of the upper or proximal surface of two specimens, Tabūn I and Skhūl V, and with them corresponding views of the second left ribs of a chimpanzee and a Sikh. We have introduced the chimpanzee rib to show that the impression for the intercostal muscles (Fig. 75 A, *e*, *f*) is narrow and confined to the inner or pulmonary border of the rib. On the

rib of the Bushman the impression has increased so as to occupy a greater area of the surface, while in the Tabūn rib the area has increased still more (Fig. 75 B, C) to an extent never seen in the second rib of modern races. With this outward extension, the outer border of the impression has undergone a great development of strength. In Skhūl V (Fig. 75 D) the outward extension is still greater, much more than in the Sikh specimen (Fig. 75 E). The series shows an unexpected specialization in the rib conformation of the Palestinian thorax. This extension of the area of attachment for the intercostal muscles is certainly a character of Neanderthal man; Boule found it in the lower ribs of the La Chapelle skeleton and Kramberger in a Krapina second rib. The Krapina rib also shows the same triangular form in cross-section as that seen in Skhūl V (Fig. 78 D). The Bushman has retained the anthropoid or primitive state to a greater extent than have the Tabūn or Skhūl specimens.

The fact that this specialization is shared by the Tabūn and Skhūl specimens can be interpreted only by supposing that however much these two types may differ in many features, we have here one which links them into a racial unity.

Another strange feature of the Tabūn second rib is brought out in Fig. 76. When we look at the under surface of the dorsal end of the second rib of the chimpanzee (Fig. 76 A), we see that, in the region of the angle, the outer or lower margin of the rib is turned down into a submarginal ridge. This is also so in the Bushman second rib (Fig. 73 B), and in those of all modern peoples. In the Tabūn specimen this margin is not turned down but is greatly strengthened and directed outwards. Cross-sections shown in Fig. 78 A, B, C, will make this character easily understood. We have here another specialization which we interpret as an indication that the upper ribs spread outwards almost horizontally over a dome-shaped apex to the lung.

In Fig. 77 we compare a lateral view of the second right rib of Skhūl IV with that of a Sikh, the specimens being placed with the corresponding points opposite each other. The dorsal part of the Skhūl specimen is missing, but the lateral part is intact to its ventral end, where the socket for the cartilage is preserved. Of the close correspondence of the two men, Skhūl IV and Skhūl V, in structure and bodily conformation, there can be no doubt, yet in Skhūl IV the second rib is ultra-modern in its characters—having a wide and thin submarginal ridge of bone along the whole of its ventral segment. The segments shown in Fig. 78 will bring home to the reader how much this rib differs from that of Skhūl V (Fig. 78 F, F′, D, D′) and from the representatives of modern races (Fig. 78 B and E). The ribs are not only wide and thin in Skhūl IV but are vertical in their position around the thoracic cavity. It is possible that we are here dealing with an abnormal feature, for it is in Skhūl IV that we meet with a scaphoid scapula (p. 132). The limb bones of this individual are, however, particularly strong and apparently normal. This feature in the second rib of Skhūl IV is another example of the plasticity of the anatomical organization of the ancient Palestinians.

There are certain items of our table of measurements which deserve comment. We were able to measure the degree of curvature of only one specimen, Tabūn I, and its curvature is considerably less than in the Bushman, in whom the curvature is less again than in most modern races (Fig. 75). In lack of curvature the Tabūn specimen resembles the Krapina example. We are also struck by the shortness of the second rib of Skhūl IV. When compared with corresponding parts of the second rib of the Sikh, a man of smaller

stature than Skhūl IV, that of the ancient man seems to have been about 20 mm. shorter. On the other hand, the second rib of the Tabūn woman is longer and stronger than in the Bushman.

Third, Fourth, and Fifth Ribs.

We give the measurements of the third, fourth, and fifth ribs in Table XXXIII (p. 128) as these form a unit of a functional series. The peculiarity of this series of ribs in the Tabūn woman will be best grasped by examining Fig. 79 B, where her fourth rib is compared with that of a Bushman. Both are viewed on the cranial aspect and arranged on the same plane, XY, passing outside the tubercle to the ventral extremity. The Tabūn rib exceeds the other very greatly in length and especially in curvature. Indeed, it may be said that the respiratory capacity of the Tabūn rib is double that of the modern representative we have chosen for comparison. When the ribs are so grouped it will be seen that the head and neck of the two almost coincide, although relative to the body of the rib, the neck, in the Tabūn specimen, has an angle wider by nearly 10°.

We have seen that the second rib of the Tabūn series is flattened, its body being in a more horizontal plane than in modern races. The third and fourth ribs, however, take on a normal inclined position. At the fifth rib a change takes place; the rib becomes shallower and more triangular in section in its dorsal segment. At the same time the articular tubercle, instead of being a section of a cylinder, becomes flat and oval, a sign that it is of the series which is directly concerned in the action of the diaphragm, and with abdominal respiration. One notices, too, that in the third, fourth, and fifth ribs the angle is placed more laterally on the ribs than in the modern races. It is placed 37 mm. from the tubercle in the fifth Tabūn rib; only 29 mm. in the Bushman. This signifies that the spinal muscles had a wider attachment to the ribs than prevails in modern races.

Our measurements of the ribs of Skhūl V has been rendered difficult by an uncertainty as to the amount which has been lost at their ventral ends. Undoubtedly the ventral end of the fourth rib of Skhūl V in Fig. 79 A has been unduly curtailed. Nevertheless, the ribs of this man were very short in relationship to his stature. The Skhūl V series differs from the Sikh series in a number of ways. The Skhūl ribs are more convex laterally than is usual in modern races. In their dorsal cross-sections they are thick from within outwards, and shallow from above downwards. In their ventral cross-sections they assume, as may be seen from Table XXXIII (p. 128), the form of flat bone plates. The change of rib form and articulation in this individual takes place at the sixth rib, not at the fifth as in the Tabūn series.

The third, fourth, and fifth ribs of Skhūl IV are too imperfect to give satisfactory data for comparison. There are, however, two remarkable features. It will be remembered that the second rib of this series had a peculiar ventral segment; it took the form of a wide and very thin plate of bone. This feature is continued in the third rib, but at the fifth it has become thicker as well as less broad and deep. Here, too, the change in rib form occurs at the fifth, which in its dorsal segment has almost a rounded form.

In all the Palestinian ribs the subcostal groove is wide and concave, the submarginal costal ridge is not greatly developed, the articular surfaces are large, and the areas for ligamentous attachment are rough and prominent.

Sixth, Seventh, Eighth, and Ninth (Diaphragmatic) Ribs.

The sixth, seventh, eighth, and ninth ribs form a functional series which is modified to serve the purpose of diaphragmatic respiration. Hence, in Table XXXIV (p. 129) we deal with them as members of a group. The sixth is a transitional rib, transitional to the thoracic group (third, fourth, fifth) which we have just considered, and still retains certain characters of the upper series. We have also arranged our data somewhat differently in Table XXXIV, giving the measurements of each individual in consecutive order. The sixth rib has the longest curvature of the costal series, although the seventh and eighth fall only a little short of it; in actual length of chord (Fig. 80) the sixth, seventh, and eighth are almost equal.

We can best introduce our table of measurements by referring first to Fig. 80. There the eighth left rib of a Bushman (A), Sikh (B), Skhūl IV (C), and Tabūn I (D) are set on their dorsal ends placed upright, and viewed from behind. It will be seen that these are arranged to form a series in which the curvature increases in degree from that in the Bushman example to that in the Tabūn woman. In Table XXXIV, lines 3, 4, 5, we give measurements of the chord, the subtense, and the ratio of the latter to the former. The index of curvature of the sixth rib is 45·4 in Tabūn I; in the Bushman 24·8. The curvature of the sixth rib in Skhūl IV is 28·2, only slightly greater than in the Sikh (27·6), but a glance at Fig. 80 will show that there is less of the lateral flattening than in the Sikh rib, his comparatively low index being due to the exceedingly great length of the chord. The space contained within the curvature of the rib, and of its base represented by the chord, is an index of the respiratory capacity of the rib. It will be seen how much, in this respect, our Palestinians exceed the modern examples with which we have compared them. Nor can any one fail to be impressed with the exceptional costal curvature of the Tabūn woman; in this respect she resembles the anthropoids, particularly the chimpanzee, and associates herself with the Neanderthal group of Europe, represented by the man of La Chapelle. Skhūl IV, on the contrary, finds his nearest counter part in the thorax of modern man. Owing to the deficiency of the ventral ends of the ribs, we could make no accurate measurements of the costal curvature of Skhūl V. Such evidence as we have for him, and the same can be said for Skhūl IX, indicates a greater curvature than in Skhūl IV; Skhūl VI, on the other hand, seems to agree in this matter with Skhūl IV.

In modern man the diaphragmatic costal series has undergone a number of changes. One of these is indicated in Fig. 81 and relates to a bending of the rib in a vertical plane, this term being employed as if our subjects were standing or sitting upright before us. We note that, with the thorax in this position, the dorsal segment descends from the spine in a downward as well as in an outward direction; then as the lateral segment is approached at the angle, the body of the rib takes on a more horizontal position. Towards the ventral end the downward trend is again accentuated. These bends, although they are developed to a certain degree in the diaphragmatic series of anthropoid apes, still retain to a major degree the upper thoracic form. These vertical bends in modern man, especially in the Caucasian stock, become very pronounced and with them appears a great flattening of the lateral segments of the ribs, all being adaptations to the human abdominal method of respiration. The changes are usually less marked in women; normally the change begins at the sixth rib.

These flexures or bends are present to only a small degree in the Tabūn woman but are pronounced in Skhūl IV, almost as much as in the Sikh. It will be noted, however, that the ventral bending is practically absent in the fossil forms (Fig. 81 A, C).

Another change which affects the diaphragmatic ribs is illustrated in Fig. 82. It concerns the diameters of the ribs; an increase of width (cranio-caudal diameter) and a decrease in thickness (medio-lateral diameter). These diameters are given in Table XXXIV (p. 129) for each rib at three points, (1) immediately distal to the angle (lines 6, 7), (2) 50 mm. from the ventral end (lines 8, 9); (3) at the mid-point of the lateral segment (lines 10, 11). We are concerned in Fig. 82 with the mid-point diameters. In Fig. 82 A we give a cross-section of the seventh rib of Neanderthal man (Düsseldorf), taken from a cast. The thickness is 10·8 mm.; the width is 17 mm.; the thickness is 63·5 per cent. of the width. We may divide ribs into three classes: the rounded, where the thickness is 50 per cent. or more of the width; the flattened, where the thickness is 40 per cent. or less of the width; and an intermediate group falling between 40 and 50 per cent. The Neanderthal rib is not only rounded but of great mass. A corresponding section of the seventh rib of Tabūn I is shown in Fig. 82 C; it, too, is rounded, but to a less degree (59·5 per cent.). The seventh Tabūn rib is of peculiar strength and conformation, and if its diameters are compared with those of its neighbouring ribs, they will be seen to exceed them greatly. We suspect that the seventh rib of Neanderthal man had also this excess in strength. The eighth rib is the largest and the strongest of the series shown in the photograph given by Boule of the left ribs of La Chapelle man, but it is possible that a mistake has been made in identification. It is the sixth rib in the chimpanzee which is thus distinguished, and it, too, is very round (85·7 per cent.). The seventh of Skhūl V also exceeds its neighbours, but in Skhūl IV there is the same relationship as in the Sikh and the Bushman. The eighth Tabūn rib, as will be seen from Fig. 82 B, is smaller in its diameters and flatter than the seventh, yet it still falls into the rounded class with an index of 54·8. From Table XXXIV (p. 129) it will be seen that the corresponding diameters of the eighth rib of the Bushman differ from those of the Tabūn woman in that the thickness is less, but the width is greater. The diameters differ in their proportions, but the bone substance remains about the same in both. The rib in the Bushman falls into the flattened series, its index being 39·1. In the ninth rib of Skhūl IX (Fig. 82 D), we see a form which is transitional, bridging the gap between the Neanderthaloid and the modern forms. Its index is 33·3, being thus in the flattened class, yet the cross-section shows the internal convexity of the Neanderthaloid rib. The same may be said of the eighth rib of Skhūl IV (Fig. 82 E); it is very wide and technically flattened, its index being 34. Yet when we compare its section with one from the corresponding rib of the Sikh (Fig. 82 F) we see how different they are, the Skhūl rib showing the medial Neanderthaloid convexity. The fact is evident that our Palestinian costal specimens provide a series which links the Neanderthaloid form in Tabūn I to the approximately modern type found in Skhūl IV.

Ribs attain their greatest width in the ninth of the costal series. This is so in Skhūl IV and in the Sikh, the former attaining the remarkable width of 22·3 mm. The upper thoracic ribs tend to be round; the diaphragmatic ones become flattened. This is true both of the gorilla and the chimpanzee. The sixth rib of the chimpanzee, for example, has an index of 85·7, the eighth rib 35·3. But in the Skhūl diaphragmatic series, as in

modern races—especially the white race—with this flattening comes a great increase in substance and strength.

We know very little concerning the diaphragmatic ribs of the Neanderthal people of Europe. Kramberger gives the diameters of an eighth rib, which are about the same as regards width as the diameters in Tabūn I; the thickness is much greater, the index being 61·7. Boule has given photographs of the left ribs of La Chapelle and they are undoubtedly Neanderthaloid—much more than is the case even in Tabūn I. He mentions, however, that the La Ferrassie male had ribs which were much more flattened than in the La Chapelle specimen. Nevertheless, the evidence is that in Europe Neanderthal man had thick narrow ribs; in our series we see the beginning of the flat diaphragmatic ribs of modern man.

We have given the diameters of the ribs near their ventral ends (Table XXXIV, p. 129) for the following reasons. In the upper thoracic ribs of Skhūl IV the ventral ends were wide and thin; an opposite condition prevails at the ventral ends of the diaphragmatic series in Tabūn I. The terminal part of the seventh, eighth, and ninth Tabūn ribs is almost round, and of the size of a lead pencil. The thickness of the seventh is 68 per cent. of the width, 69 per cent. in the eighth and 62 per cent. in the ninth rib. The ventral ends of the upper thoracic ribs of the chimpanzee, down to and including the sixth, have this rounded, pencil-like form, but in the diaphragmatic series the flat form prevails. It is the opposite in Tabūn I; the upper are flat, the diaphragmatic are rounded. A marked decrease in width is seen at the ventral ends of the eighth and ninth ribs of Skhūl IV and this condition was probably present in Skhūl V. This is, as far as we can learn, a feature not previously observed in the human body, ancient or modern.

In Fig. 83 we have sought to epitomize certain Neanderthaloid features manifested by the vertebral ends of the Palestinian ribs. The outstanding character of the ribs of Neanderthal man is the massiveness and strength of the medial ridge (Fig. 83 A, B, *b*). It is seen in section in Fig. 82 A. The medial ridge bounds the subcostal groove, forming the floor (or roof) of the groove. It contributes both to the thickness and the strength of the rib. It is developed with particular strength in the dorsal halves of the lower ribs of Neanderthal man, especially where the neck of the rib passes into the body. The medial ridge finds its maximum development in the eighth and ninth ribs. When we trace the medial ridge towards the head of the rib, we see that it passes into the lower border of the neck, while the upper border of the body of the rib is continued into the upper margin of the neck. This ridge is almost as prominent in the ribs of Skhūl V as in those of Neanderthal man (Fig. 83 B, B′, A, A′). The medial costal ridge is much less prominent in the ribs of modern races; it passes obscurely into the neck, fusing with and strengthening the lower border (Fig. 83 C, C′). The medial ridge in Skhūl IV, as it passes into the neck, becomes moderate and modern in its development (Fig. 83 D, D′).

Cross-sections of the costal neck made along a line (*X–X*) shown in the drawings are given in Fig. 83. These bring out two features of the neck of the Palestinian rib. The massiveness and width of the section across the Neanderthal rib will be noted (Fig. 83 A′). Two other features of this section are important. The forward development of the lower margin of the neck (*b*) gives rise to an extensive surface under the neck and in front of the articular facet. The neck in the seventh rib in Skhūl V shows a much smaller sectional area (Fig. 83 B′) and the prominent lower border and surface are evident. The other

feature of the neck to which we would call attention is a ridge (Fig. 83 A′, *r*), which grows upwards on the dorsal surface of the neck. There is no sign of this ridge in the seventh or eighth ribs of Skhūl V, but in the lower ribs from seven onwards in modern man this upper ridge of the neck becomes a prominent feature (Fig. 83 C, *r*). This ridge is placed just behind (dorsal to) the upper border of the neck in the modern rib. It becomes more or less continuous with the upper margin of the head in the tenth and eleventh ribs of modern races. The latter is the case in Skhūl IV, as high as the eighth rib—a very modern feature (Fig. 83 E). The head is defective in the eighth left rib of Skhūl IV, but on the right side it is well preserved and we have shown the right, reversed, so that it may be compared directly with the left ribs in Fig. 83. In Skhūl IV the medial ridge almost fades out as it enters the neck, a modern feature. So little is the lower margin of the neck developed that the lower margin of the articular facet appears in our anterior view (Fig. 83 E, *c*). The large size of the articular facet is clearly indicated.

We have in the lower ribs of the Mount Carmel people specimens which vary towards the extreme Neanderthal type on the one hand and towards the condition which prevails in modern races on the other.

Tenth, Eleventh, and Twelfth Ribs.

The measurements relating to the tenth, eleventh, and twelfth ribs are set out in Table XXXV (p. 130). The arrangement is the same as in Table XXXIV (p. 129) where the figures are given consecutively for each individual. This is especially necessary in a series of ribs which show stages in retrogression as we descend. In order to prepare readers for what we may call a normal rate of retrogression we place beside the measurements relating to the ribs of the Tabūn woman, those of a Bushman. Likewise we compare measurements relating to the Skhūl men with those of a Sikh, as in previous and succeeding chapters. We may say at once that the successive degrees of retrogression in the Palestinian series are such as would be normal in modern people. Unfortunately the dorsal ends of the Tabūn ribs are missing, but from an examination of the parts preserved we feel confident that the lowest ribs were not longer in the Tabūn woman than in the Bushman. On the other hand, they are stouter, thicker, but less wide than in the Bushman and their curvature was greater. No trace of either right or left twelfth rib of the Tabūn woman was found.

The man, Skhūl IV, provides us with a complete series. If the measurements we have given in Table XXXV (p. 130) are compared with those made on the corresponding ribs of the Sikh, there will be found evidence of a remarkable agreement both in dimensions and in form. The Skhūl ribs are thicker, more curved, rather less wide, and certainly shorter.

We have only the tenth of the lower ribs of Skhūl V. Its ventral end is missing but, by comparing the part preserved with the same rib in Skhūl IV and in the Sikh, we are confident that this rib in Skhūl V was longer than in the two others. This is welcome information, for the upper thoracic ribs of Skhūl V were undoubtedly shorter than we should expect from his stature. Apparently there was compensation in the diaphragmatic and lower ribs. His tenth rib in its dorsal segment shows the same Neanderthaloid characters as did the sixth, seventh, eighth, and ninth. This is also evident from our measurements. In cross-section the dorsal segment of this tenth rib is triangular in shape.

We have also the tenth and eleventh ribs of Skhūl IX, one of the most interesting and

peculiar of our male series. The ribs of this individual are intermediate in character between Skhūl V and Skhūl IV.

The heads of ribs are seldom preserved in fossil specimens, subject as they are to dissolution or breakage. It was a piece of good fortune to recover the head of the tenth rib of Skhūl IV, on both sides; the right is the more perfectly preserved. We have used this specimen, the tenth right rib, for a comparison with the corresponding ribs of a chimpanzee and of a Sikh (Fig. 84 A, B). We find the articular surface on the head of this rib in the chimpanzee preserving contacts for adjacent vertebrae, whereas in the Sikh and in Skhūl IV the articular surface is single. It is more extensive in the Skhūl specimen than in the Sikh. The tubercle in the chimpanzee retains its normal articular facet; this has disappeared from both the other specimens. Indeed, the tubercle is more degenerate in the ancient than in the modern example. In all three the upper process (tubercle) of the neck is present and in all three it is more or less confluent with the upper margin of the head. This process is also present in the tenth rib of Skhūl V. We have noted already the fact that this process is confluent with the head of the eighth rib of Skhūl V. Unfortunately we do not know the condition of the head of the tenth rib in Tabūn I and there is no record of its condition in Neanderthal man.

Summary.

We take this opportunity to summarize the chief features of the costal series in each of our fossil people. We meet with evidence of a capacious thorax in the Tabūn woman, especially when we take into account her stature. She had a rounded, barrel-shaped chest, ribs which were well curved, and were set more horizontally than is the case in modern people. The ribs were not wide, but thick relative to their width. The first three ribs expanded laterally quite rapidly so as to form a dome-shaped top to the thorax. The ventral ends of the seventh, eighth, ninth, and tenth ribs were peculiar, being rounded and pencil-shaped.

Skhūl VII is the only other Carmel woman to provide costal data for comparison with the Tabūn woman. We have only fragments of several ribs, mostly upper, and these are more like the Skhūl or modern type than is the case with Tabūn I. The rib fragments are not so thick and rather wider than in the corresponding parts in the Tabūn woman.

Our men, so far as their ribs are concerned, form a series passing from a Neanderthaloid condition in Skhūl V to an almost modern conformation in Skhūl IV. Even in the case of Skhūl V, however, the characters of his ribs are very different from those of Neanderthal man. Between these two individuals we would fit in Skhūl IX near to Skhūl V, and Skhūl VII (female) near to Skhūl IV. It is quite true that there are differences in curvature, in thickness, and in conformation between the ribs of Skhūl IV and those of a modern representative of the Caucasian stock, yet there cannot be any hesitation in concluding that Skhūl IV, in rib structure and arrangement, is much nearer to the modern type than to the Neanderthal type of western Europe.

THE STERNUM (Figs. 85–87)

The Sternum forming an essential part of the thorax and of the respiratory system is included in this chapter.

We can find no record, in the publications of our predecessors, of the discovery of

any part of the sternum of the earlier forms of fossil man. Even in the case of the Cro-magnons, Verneau had to lament that only mere fragments were found. We are in a happier position, having a representation of this bone in four individuals. Three segments of the corpus or body of the bone of Tabūn I (Fig. 87 A) are preserved. In Skhūl IV there is the greater part of the corpus with the xiphoid process attached to it. Part of the corpus of Skhūl VII (female) (Fig. 97 C) remains and there is a fragment of the manubrium of Skhūl IX (male) (Fig. 98).

Skhūl IX.

Only a small fragment of the manubrium of Skhūl IX was recovered. It is shown in Fig. 85, set within the outline of the manubrium of a male Australian. The spine of the scapula of this individual is big and strong; so is the proximal part of the femur. The sex is male. Yet the dimensions are less than those of the manubrium with which it is compared. The total width of the part recovered is 38 mm.; about 10 mm. is missing from the width. The width of the jugular (supra-sternal) notch is 27 mm.; the thickness of the upper border near the mid-point is 8·5 mm. The clavicular facet, which is inflated and almost square in shape, save that the angles are rounded, has a thickness of 13 mm. It differs from all manubria which we have seen by the thickness of its upper border, which suddenly becomes a thin plate as it descends (Fig. 85). It is true this fragment has been subjected to great compression but the thinness and structure of the dense plate, 3 mm. in its lower part, cannot be explained as altogether the result of compression.

Skhūl IV.

The sternum of Skhūl IV is the most complete and also the most peculiar of the fossil specimens (Fig. 86 A). The upper part of the first segment is missing; the estimated extent of this missing part is indicated by a broken line, being made the same length as the first segment of the sternum of a Sikh (Fig. 96 B) with which it is compared. The covering table of bone is missing from the greater part of the anterior surface but the costal facets are intact. The actual length of the part preserved, including the xiphoid process, is 113 mm. The latter process which is divided into unequal prolongations (Fig. 86 A) is 25 mm. long, so that the part of the body preserved measures 88 mm. We have added 15 mm. for the part missing, thus obtaining an original length of 103 mm. In the Sikh sternum the body measures 101 mm., the xiphoid process 33 mm., 8 mm. more than in Skhūl IV. At its widest point, which lies immediately above the insertion of the sixth pair of costal cartilages, the Skhūl sternum measures 46 mm., 44·6 per cent. of the estimated length. It is a remarkably wide sternum. The widest point in the Sikh sternum lies above the insertion of the fifth pair of cartilages; here the width is 36 mm., this being 35·6 per cent. of the length of the corpus and representing a common ratio in the sternum of modern man. The shape of the Skhūl sternum indicates a very great development of the lower ribs, especially the sixth, seventh, and eighth, which we have already found to be the case. We know of no modern race that has a similar sternal development.

The measurements of the thickness at the widest point are alike in Skhūl IV and in the Sikh; 10 mm. In both, too, the thickness of the first sternal segment is the same, 9 mm. The width of this segment was also approximately the same, 27 mm. in the fossil

sternum, 25 mm. in the modern. The facet for the seventh costal cartilage is very wide (18 mm.) and is situated partly on the base of the xiphoid, as in the modern sternum. There is no apparent facet or contact for the eighth pair of costal cartilages. The gorilla has a very wide sternum but we see no affinity between the Skhūl and gorilline types.

Tabūn I.

The evidence of the teeth, the sutures of the skull vault and other structures indicates that the Tabūn woman was a young adult, about 25 years of age. Apparently the segments of her sternum remained ununited, which is a remarkable fact, recalling the condition found in the sternum of the chimpanzee. The parts found are shown in Fig. 87 A; they are three in number, consisting of (1) the greater part of the first segment; (2) the second segment, almost entire; (3) the most distal segment, separated into two parts. The portion from the right side carries a long, oblique impression for the sixth and seventh costal cartilages (length, 15 mm.) and descends to the point of junction with the base of the xiphoid. The left part of this segment is defective. The entire third sternal segment is missing.

There is a foramen at the proximal end of the fourth segment—a sternal foramen (Fig. 87 A, *f*) which occurs with varying frequency in modern races, 7 per cent. of Europeans, 13 per cent. of South American Indians (Martin, 1928, vol. ii, p. 1091). The separation below the foramen does not seem to be due to a fracture. We infer that the missing third segment showed a condition similar to that seen in the Bushman sternum, with which the Tabūn sternum is compared (Fig. 87 B).

If we compare the various segments of the Tabūn sternum with those of the Bushman, the latter are rather shorter, of about the same width, but thinner. The first segment of the Tabūn sternum has the following dimensions: length, 32 mm.; width, 21 mm.; thickness, 6·6 mm. The corresponding measurements in the Bushman are: length, 29 mm.; width, 21 mm.; thickness, 6·2 mm. The second Tabūn segment gives a length of 29 mm.; width, 22 mm.; thickness, 7 mm. The corresponding figures in the Bushman are: 27 mm.; 26 mm.; 6 mm. For the last Tabūn segment the figures are 27 mm.; 35 mm.; 9 mm. As in the sternum of Skhūl IV, the greatest width of the Tabūn sternum appears to have been above the insertion of the sixth pair of ribs. Here, too, is the point of greatest thickness. As reconstructed, the body of the Tabūn sternum measures 104 mm. in length, slightly more than even the large Skhūl sternum. The greatest width, 35 mm., represents a length-width ratio of 33·6 per cent., 2 points lower than in the Sikh and 11 points lower than in Skhūl IV.

Skhūl VII.

It is fortunate that part of the sternum of this individual was found, because the difference between the Skhūl male and the Tabūn female sternum at first seems too great to be due to either sexual or individual variability. There can be no doubt that Skhūl VII is a member of the Skhūl series and all the parts of the skeleton indicate the female sex. The preserved part of the sternum of Skhūl VII is shown in Fig. 87 C. It represents the first segment of the body and the upper part of the second, the two being completely fused. The length of the whole fragment is 45 mm., the first segment making up 31·5 mm. of this amount. Its length is thus almost the same as that of the Tabūn first

segment (32 mm.). The width of the segment (at its midpoint) is also nearly the same, being 22 mm. It is slightly thicker, being 7 mm., instead of 6·6 mm. Thus the first segment of Skhūl VII and Tabūn I have almost identical dimensions.

Summary.

The sternum of Skhūl IV shows several remarkable, highly specialized characters, especially the great width of its fourth segment. It differs from any modern sternum known to us but whether it agrees with the sternum of the Neanderthal forms found in Europe we cannot say, for lack of evidence.

The sternum of Tabūn I is primitive in the separation of its segments and in its great length. Yet it shows the same wide fourth segment as does the sternum of Skhūl IV. Further, the first segment of the sternum of Skhūl VII has the same dimensions as the first segment of the Tabūn sternum.

COSTAE

Table XXXI. FIRST RIB

	Skhūl IV	*Krapina*	*Sikh*	*Skhūl VI*
	L	R	L	L
Length: M 1				
greater curv. of frag.	82·0	..	102·0	63·0
estim. or actual length	102·0	..	102·0	..
tuberculo-ventral chord*	85·0	80–86†	89	..
Width:				
at scalene tubercle	20·0	17·5	18·5	..
at ventral end	15·2	..	17·5	16·6
Thickness:				
at scalene tubercle	5·0	..	4·2	..
at ventral end	9·8	6·1	8·3	9·5
of outer border between costal tuberosity and carotid gr.	6·2	5·2	6·0	..

* Measured from the dorsal border of the costal tuberosity to the ventral end of the rib.

† Measurement made from a photograph (Kramberger, 1906, Plate IX, No. 6). Other measurements after Kramberger.

Table XXXII. SECOND RIB

	Tabūn I	*Bushman*	*Skhūl IV*	*Skhūl V*	*Sikh*	*Krapina**
	L	L	R	L	L	R
Length:						
greater curv. of frag.	155·0	147·0	127·0	125·0	203·0	74·3
estim. or actual length	160·0	147·0	170·0	..	203·0	..
tuberculo-ventral chord†	125·0	116·0	..	(105·0)	147·0	..
subtense of curvature‡	39·0	41·0	..	(31·0)	59·0	..
Radio: subtense to chord	31·2	35·3	..	(29·5)	40·1	..
Dorsal diameters:						
dorso-ventral§	7·0	5·5	..	8·0	7·1	..
proximo-distal‖	9·7	9·9	..	16·0	12·7	..
Ventral diameters:						
dorso-ventral ¶	4·7	3·4	3·2	(3·8)	4·3	5·0
proximo-distal**	11·0	9·0	17·7	(7·6)	10·7	11·0

* After Kramberger (1906, p. 213). † Fig. 75, chord X–Y.
‡ Fig. 75, subtense O–P.
§ Least diameter measured between the pleural and the outer surfaces, 10 mm. lateral to the tuberosity.
‖ Measured at right angles to the dorso-ventral diameter.
¶ Least diameter measured between the pleural and the outer surfaces 50 mm. lateral to the ventral end.
** Measured at right angles to the dorso-ventral diameter.

Table XXXIII. THIRD, FOURTH, AND FIFTH RIBS

	Tabūn I			*Bushman*			*Skhūl V*			*Skhūl IV*			*Sikh*		
	L III	L IV	L V	L III	L IV	L V	L III	R IV	L V	R III	L IV	R V	L III	L IV	L V
Length:															
greater curv. of frag.	254·0	275·0	165·0	199·0	225·0	230·0	183·0	234·0	253·0	177·0	220·0	186·0	252·0	274·0	284·0
estimated or actual	274·0	280·0	..	199·0	225·0	230·0	250·0	260·0	260·0	250·0	..	265·0	252·0	274·0	284·0
tuberculo-ventral chord	174·0	182·0	..	152·0	173·0	185·0	..	197·0	192·0	..	..	..	182·0	204·0	221·0
subtense of chord	77·0	79·0	..	53·0	54·0	53·0	..	65·0	60·0	..	..	..	69·0	66·0	71·0
Ratio: subtense to chord	44·2	43·4	..	34·8	31·2	28·6	..	33·0	31·2	..	..	..	37·8	32·3	32·1
Dorsal diameters:*															
dorso-ventral (least)	5·0	4·5	6·7	4·4	4·6	6·0	6·3	8·9	9·2	6·5	6·5	7·5	6·3	7·2	8·3
proximo-distal	10·5	12·8	9·2	10·2	10·1	8·0	11·0	12·8	10·2	13·5	13·0	12·8	12·2	12·7	12·0
Ventral diameters:															
dorso-ventral	4·0	5·0	5·7	3·3	3·7	4·0	5·2	5·2	5·0	3·2	4·0	5·5	4·2	5·2	5·6
proximo-distal	9·9	10·3	11·8	9·0	11·3	12·0	11·3	17·0	(18·0)	20·0	17·0	16·0	13·4	13·0	14·8

* Diameters of the dorsal part of the rib were measured immediately lateral to the angle, not 10 mm. lateral to the tuberosity as in Table XXXII, above. Other measurements were made as in Table XXXII.

Table XXXIV. SIXTH, SEVENTH, EIGHTH, AND NINTH (DIAPHRAGMATIC) RIBS

	Tabūn I				*Bushman*				*Skhūl V*			
	L VI	L VII	L VIII	L IX	L VI	L VII	L VIII	L IX	L VI	L VII	L VIII	L IX
Length:												
greater curve of frag.	295·0	304·0	283·0	220·0	240·0	236·0	230·0	214·0	267·0	220·0	202·0	190·0
estimated or actual	305·0	310·0	290·0	265·0	240·0	236·0	230·0	214·0	272·0	..	..	250·0
tuberculo-ventral chord	185·0	206·0	197·0	(195·0)	205·0	206·0	204·0	190·0	(220·0)	..	..	190·0
subtense of chord	84·0	81·0	73·0	(55·0)	51·0	45·0	45·0	44·0	(55·0)	..	..	52·0
Ratio: subtense to chord	45·4	39·3	37·0	(28·3)	24·8	21·8	22·0	23·1	(25·0)	..	..	27·3
Dorsal diameters:												
dorso-ventral (least)	6·0	8·2	6·9	7·3	5·8	6·8	6·7	5·7	10·9	10·5	10·0	9·0
proximo-distal	11·3	13·8	13·2	13·7	9·0	10·0	13·8	13·2	16·0	15·0	14·6	(16·0)
Ventral diameters:												
dorso-ventral	5·3	7·2	6·3	5·2	5·0	5·0	4·0	4·0	8·7	7·0	7·0	..
proximo-distal	11·4	10·5	9·1	8·3	10·8	12·0	10·4	10·0	17·0	18·7	17·0	..
Lateral seg., mid-pt. diams.:												
medio-lateral (thickness)	6·2	8·1	6·7	6·0	5·4	5·2	4·8	4·5	8·3	10·2	6·2	6·5
proximo-distal (width)	10·7	13·6	12·2	13·2	11·2	13·3	13·4	14·2	15·0	20·0	21·0	18·0
circumference	27·0	35·0	30·5	31·5	28·0	31·0	32·0	33·0	40·0	40·0	..	..

Table XXXIV (continued)

	Skhūl IV				*Sikh*				*Skhūl IX*	*Krapina*	*Neanderthal (cast)*
	R VI	L VII	L VIII	L IX	L VI	L VII	L VIII	L IX	L IX	VIII	L VII
Length:											
greater curv. of frag.	327·0	240·0	308·0	250·0	291·0	281·0	270·0	250·0	168·0	141·0	105·0
estimated or actual	330·0	..	308·0	252·0	291·0	281·0	270·0	250·0	235·0	..	..
tuberculo-ventral chord	248·0	..	223·0	190·0	228·0	227·0	224·0	207·0	..	..	..
subtense of chord	70·0	..	60·0	52·0	65·0	57·0	53·0	55·0	..	..	..
Ratio: subtense to chord.	28·2	..	26·9	27·3	27·6	25·1	23·6	26·5	..	..	..
Dorsal diameters:											
dorso-ventral (least)	10·4	..	9·6	7·6	8 6	9·2	6·8	7·5	(5·0)	..	10·1
proximo-distal	15·2	..	14·6	19·2	17·0	18·2	19·6	20·0	17·2	..	15·0
Ventral diameters:											
dorso-ventral	5·5	3·8	5·4	6·0	6·5	6·3	4·3	5·2	..	..	..
proximo-distal	17·5	19·0	12·7	13·0	14·0	15·0	12·0	10·8	..	..	..
Lateral seg., mid-pt. diams.:											
medio-lateral (thickness)	6·6	6·8	7·3	6·5	7·0	6·5	5·7	6·0	6·4	7·6	10·8
proximo-distal (width)	16·0	18·5	21·5	22·3	16·0	18·0	18·3	20·5	19·2	12·3	17·0
circumference	39·0	59·0	46·5	50·0	38·0	42·0	42·0	46·0	..	..	..

Measurements are the same as in Table XXXIII.

Table XXXV. TENTH, ELEVENTH, AND TWELFTH RIBS

	Tabūn I		*Bushman*			*Skhūl V*	*Skhūl IV*			*Sikh*			*Skhūl IX*		*Neanderthal (cast)*
	L X	L XI	L X	L XI	L XII	L X	L X	L XI	L XII	L X	L XI	L XII	L X	L XI	L XII
Length:															
greater curv. of frag.*	185·0	156·0	..	..	..	158·0	225·0	..	77·0	..	..	..	109·0	100·0	87·0
estimated or actual	195·0	160·0	202·0	147·0	75·0	230·0	227·0	197·0	100·0	241·0	190·0	120·0	190·0	..	152·0
Curvature:															
chord†	..	..	165·0	148·0	75·0	..	172·0	164·0	..	186·0	158·0	107·0	..	..	..
subtense	..	..	44·0	32·0	10·0	..	56·0	44·0	..	58·0	42·0	23·0	..	..	..
Length neck‡	..	..	7·3	4·5	..	..	12·5	..	..	17·3	..	..	..	..	..
Dorsal diameters:§															
dorso-ventral	6·8	5·4	6·3	5·0	3·4	8·0	7·2	5·6	4·3	6·5	5·3	5·5	6·5	5·4	..
proximo-distal	10·5	7·3	7·2	7·5	7·2	8·4	11·0	11·5	7·7	10·4	10·7	9·4	12·7	10·5	..
Lateral segm., diameters:‖															
medio-lateral	5·8	4·4	3·6	4·5	2·6	5·3	6·0	6·0	3·7	4·2	4·6	4·2	6·3	5·0	7·5
proximo-distal	12·7	10·5	13·8	11·5	8·5	17·3	17·5	18·2	10·7	19·2	15·3	9·6	14·4	12·0	13·7

* Measured along the greater curvature of the rib from the dorsal margin of the articular surface of the head to the ventral end.
† Taken from the dorsal margin of the head to the ventral end.
‡ Measured from the dorsal margin of the articular surface of the head to the ventral margin of the articular tubercle.
§ Dorsal diameters: Taken midway between the head and the angle.
‖ Lateral segment diameters: at the widest part of the rib ventral to the angle.

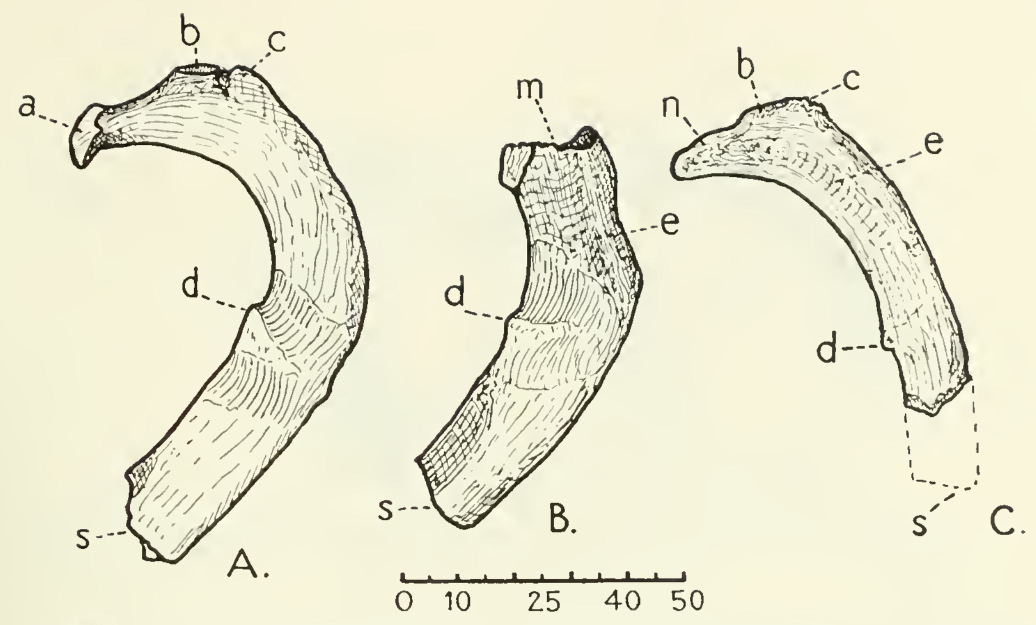


Fig. 74. First Rib, Left Cranial Aspect. A, Sikh; B, Skhūl IV; C, Krapina (traced from a photograph). *a*, head; *b*, articular end; *c*, ligamentous part of tuberosity; *d*, scalene tubercle; *e*, groove; *s*, sternal end; *m*, fractured dorsal end of Skhūl IV, about 10 mm. ventral to the tuberosity; *n*, neck of the Krapina specimen, with head missing.

Fig. 75. Second Rib, Left Cranial Aspect. A, Chimpanzee; B, Bushman; C, Tabūn I; D, Skhūl V; E, Sikh. The method of measuring the chord (*X–Y*) and the subtense (*O–P*) of the curvature is shown for the chimpanzee and the Sikh specimens. *a*, head; *b*, articular part of tuberosity; *c*, submarginal ridge; *e*, inner and *f*, outer margins of the intercostal impression; *v*, ventral end, for cartilage; *d*, special area in the Tabūn specimen (p. 118).

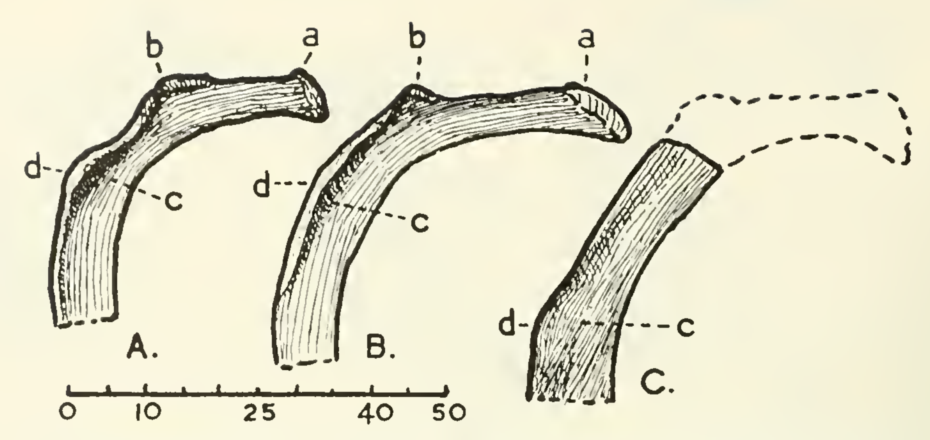


Fig. 76. Second Rib, Left Caudal Aspect of the Dorsal End. A, Chimpanzee; B, Bushman; C, Tabūn I. *a*, head; *b*, articular part of tuberosity; *c*, sub-marginal groove; *d*, marginal ridge.

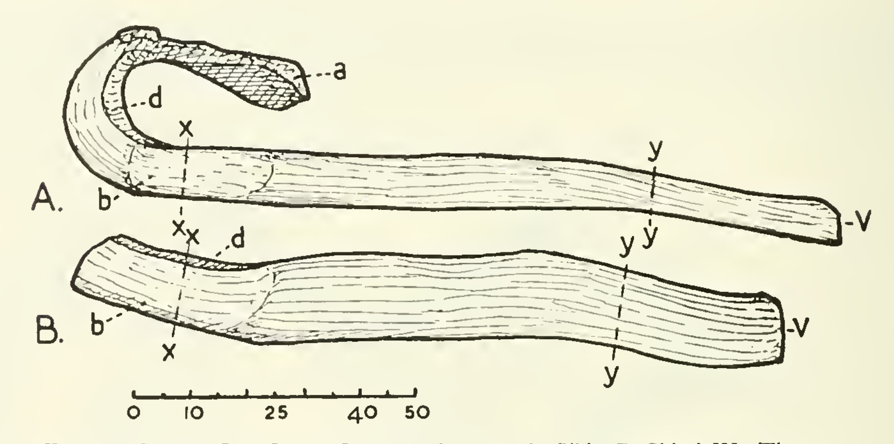


Fig. 77. Second Rib, Right Lateral Aspect. A, Sikh; B, Skhūl IV. The two are arranged to bring corresponding points in apposition. *a*, head; *b*, impression for serratus anterior; *v*, ventral end; *d*, impression for intercostal muscles; *x–x*, *y–y*, positions of the cross-sections shown in Fig. 78, E, F, E′, F′.

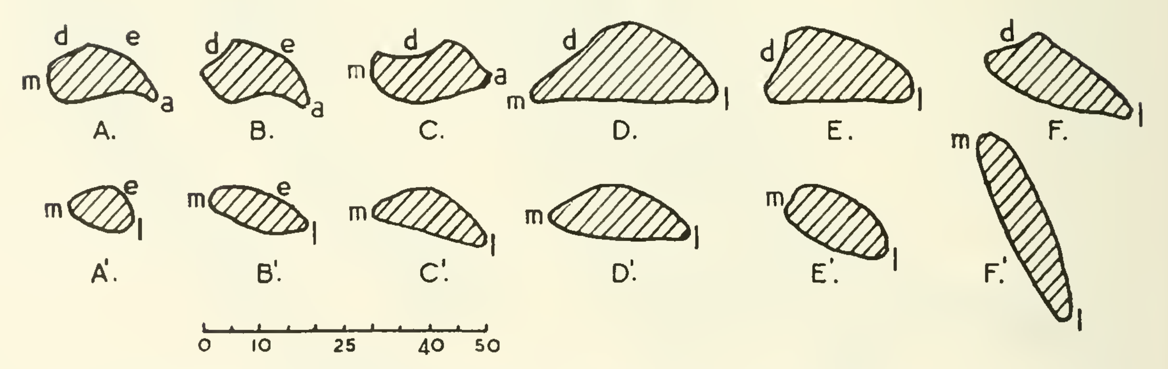


Fig. 78. Second Rib. Cross-sections of: A, A′, Chimpanzee; B, B′, Bushman; C, C′, Tabūn I; D, D′, Skhūl V; E, E′, Sikh; F, F′, Skhūl IV. A, upper series, were made 10 mm. distal to the costal tuberosity; B, lower series, were made 50 mm. proximal to the ventral end. The cross-sections E, F were made at the points indicated in Fig. 77 (for measurements, Table XXXII). *m*, proximal border; *a*, lateral border at sub-marginal flange; *l*, distal border; *e*, external surface; *d*, intercostal impression.

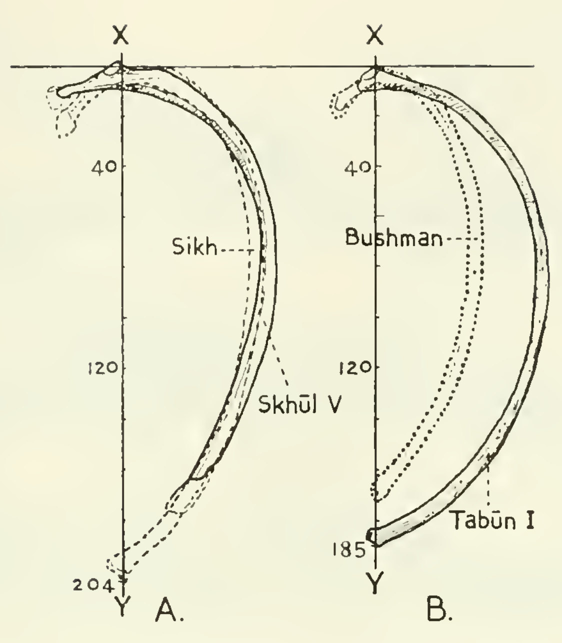


Fig. 79. Fourth Rib, Left Cranial Aspect. A, Skhūl V (solid line), superimposed upon the corresponding rib of a Sikh (broken line). B. Tabūn I (solid line), superimposed upon the fourth rib of a Bushman (broken line). $X-Y$, tuberculo-ventral axis.

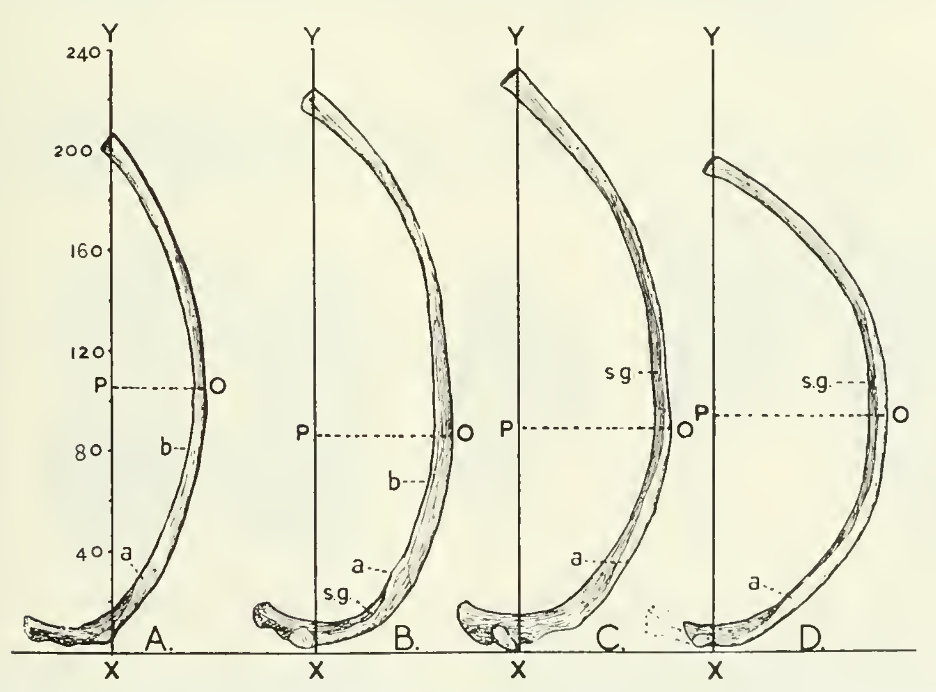


Fig. 80. Eighth Rib, Left Caudal Aspect. A, Bushman; B, Sikh; C, Skhūl IV; D, Tabūn I. $X-Y$, tuberculo-ventral chord; $O-P$, sub-tense of costal curvature; *a*, sub-marginal ridge at angle; *b*, subcostal margin of lateral segment; *s.g.*, subcostal groove.

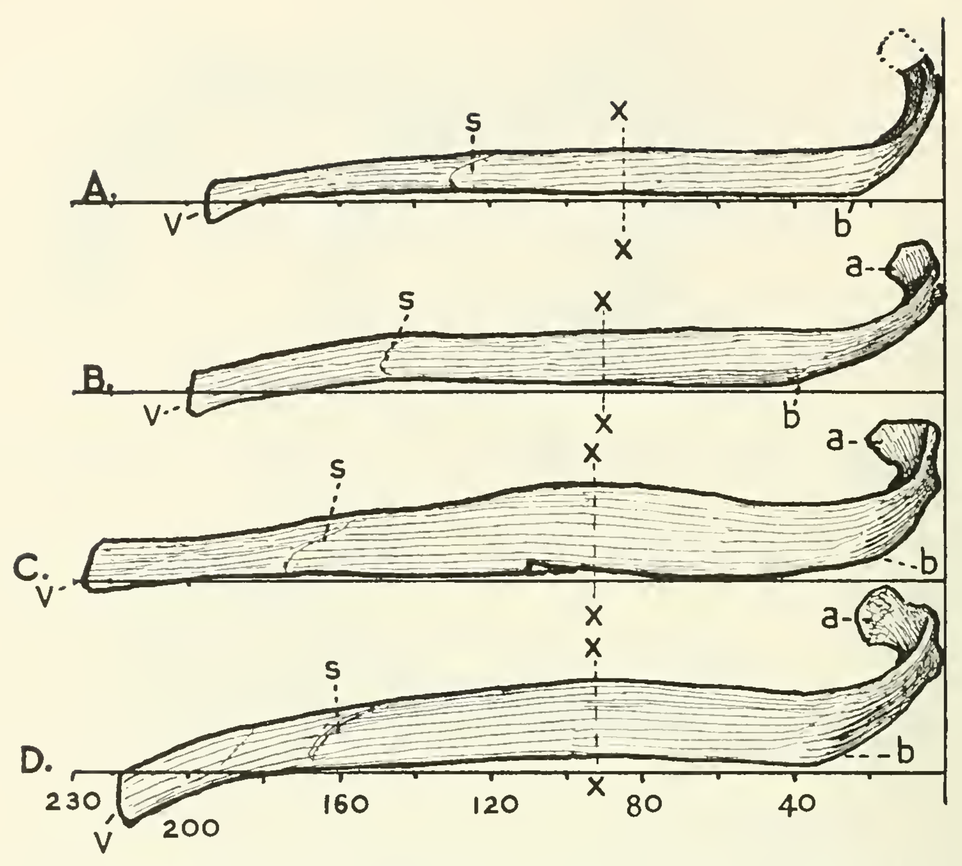


Fig. 81. Eighth Rib, Left Lateral Aspect. A, Tabūn I; B, Bushman; C, Skhūl IV; D, Sikh. The specimens are shown with the inferior margin of the lateral segment approximating the horizontal; the blade of this segment is almost vertical. *b*, angle; *a*, head; *s*, anterior limit of attachment of serratus anterior; *v*, ventral end. *x–x*, site of cross-sections (Fig. 82).

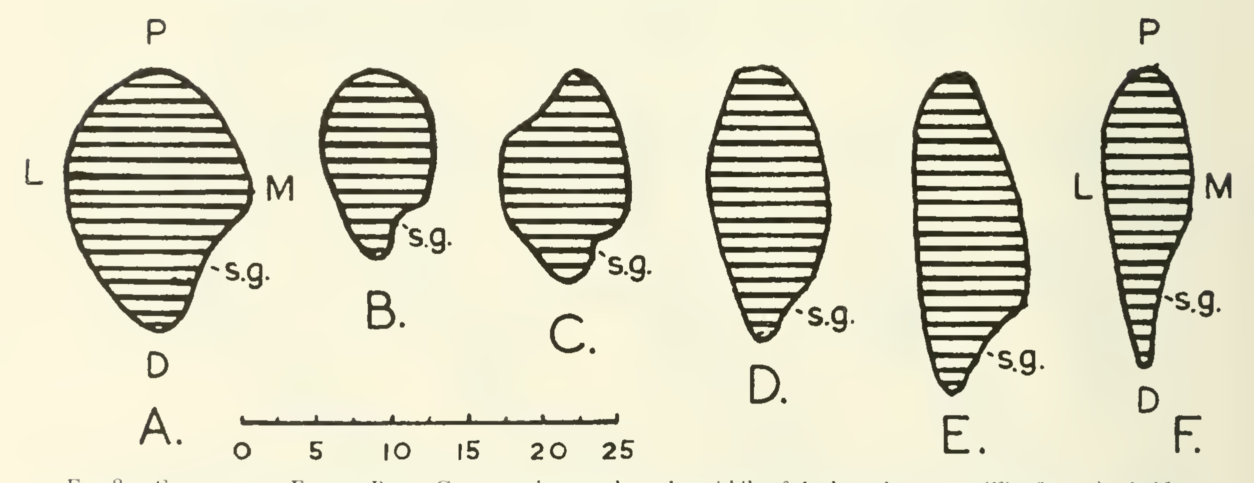


Fig. 82. Seventh and Eighth Ribs. Cross-sections made at the middle of the lateral segment (Fig. 81 *x–x*). A, Neanderthal (cast), seventh left; B, Tabūn I, eighth left; C, Tabūn I, seventh left; D, Skhūl IX, ninth left; E, Skhūl IV, eighth left; F, Sikh, eighth left. *P*, proximal margin; *D*, distal margin; *L*, lateral (outer) aspect; *M*, medial (pleural) aspect; *s.g.*, subcostal groove.

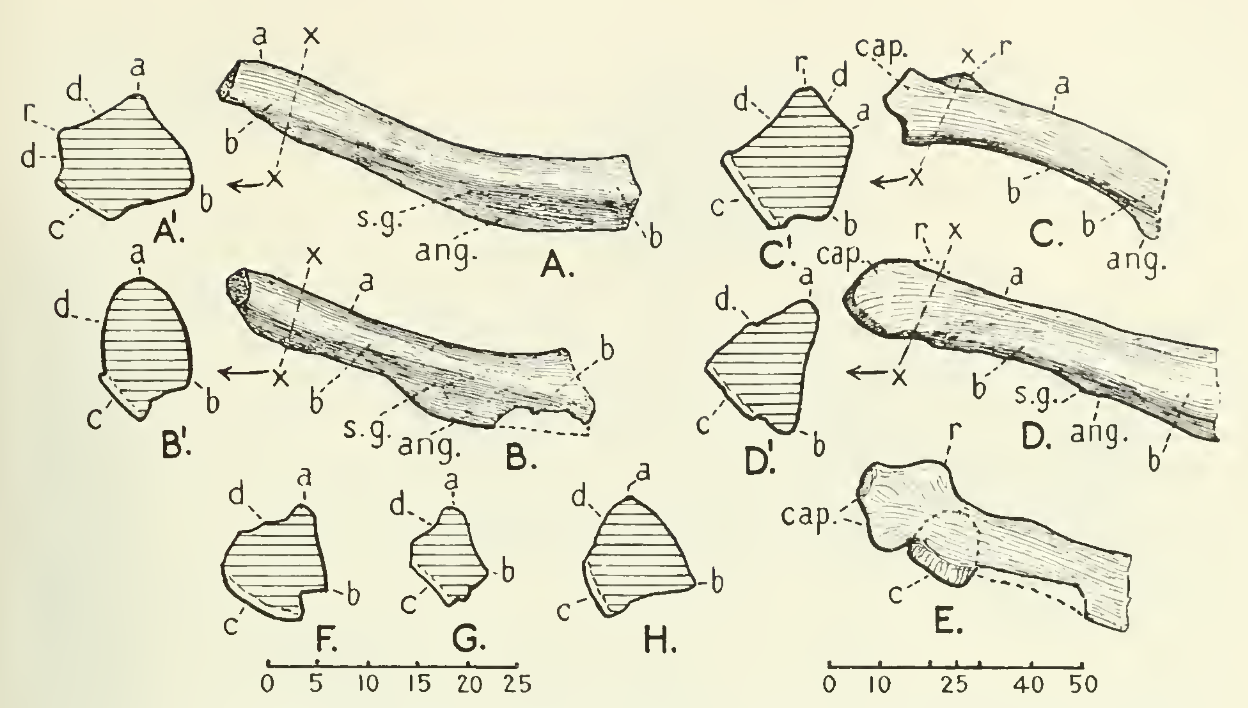


Fig. 83. Dorsal Ends of the Lower (Diaphragmatic) Ribs. A, Neanderthal (cast), anterior view of the seventh rib. A′, cross-section at *x–x* in A; B, Skhūl V, the seventh left rib, showing Neanderthaloid characters; B′, cross-section of neck; C, Sikh, the eighth left rib; C′, cross-section of neck; D, Skhūl IV, the eighth left rib; D′, cross-section of neck; E, Skhūl IV, the eighth right rib (reversed, to make it directly comparable with D); F, Tabūn I, cross-section of the neck of the seventh left rib; G, Tabūn I, cross-section of the neck of the eighth left rib; H, Skhūl IX, cross-section of the neck of the eighth left rib. (All cross-sections are twice natural size.) *x–x*, cross-section of neck; *a*, proximal border; *b*, upper medial margin of subcostal groove; *c*, articular tubercle; *d*, dorsal surface of neck (which may be divided by a ridge or process); *r*, upper process of neck; *s.g.*, subcostal groove; *ang.*, marginal crest at angle; *cap.*, head of rib.

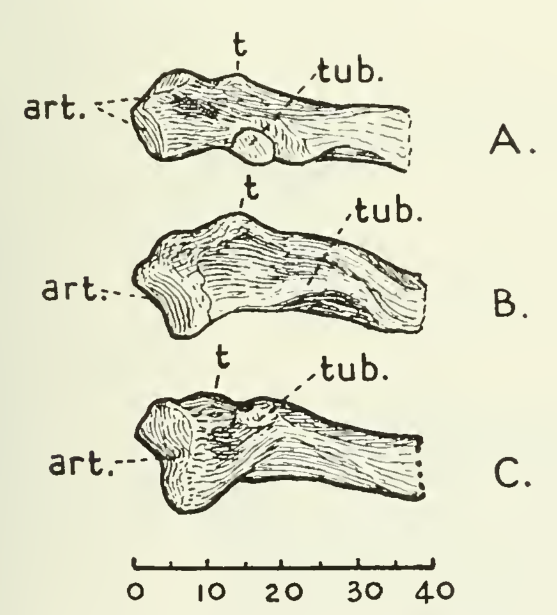


Fig. 84. The Tenth Rib, Right Dorsal Aspect of the Head, Neck, and Tubercle. A, Chimpanzee; B, Sikh; C, Skhūl IV. *art.*, articular surface of head; *t*, upper process (tubercle) of neck; *tub.*, tuberosity of rib, articular in A, non-articular in B and C.

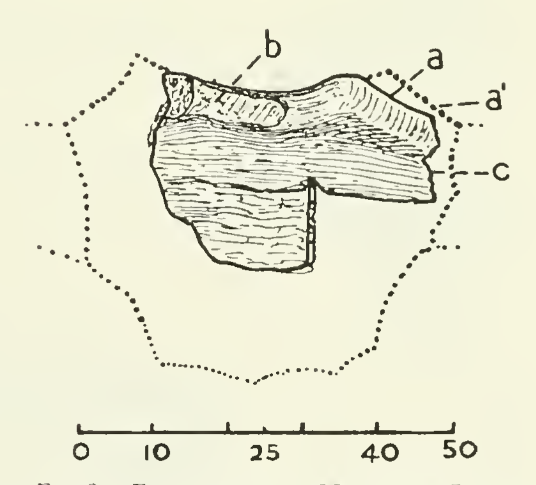


Fig. 85. Fragment of the Manubrium Sterni of Skhūl IX, set within the corresponding part of the sternum of a male Australian aborigine. *a*, clavicular articular surface of Skhūl IX; *a′*, clavicular surface of the Australian sternum; *b*, fractured surface on upper ridge; *c*, lateral extension reaching almost to the junction with the first rib.

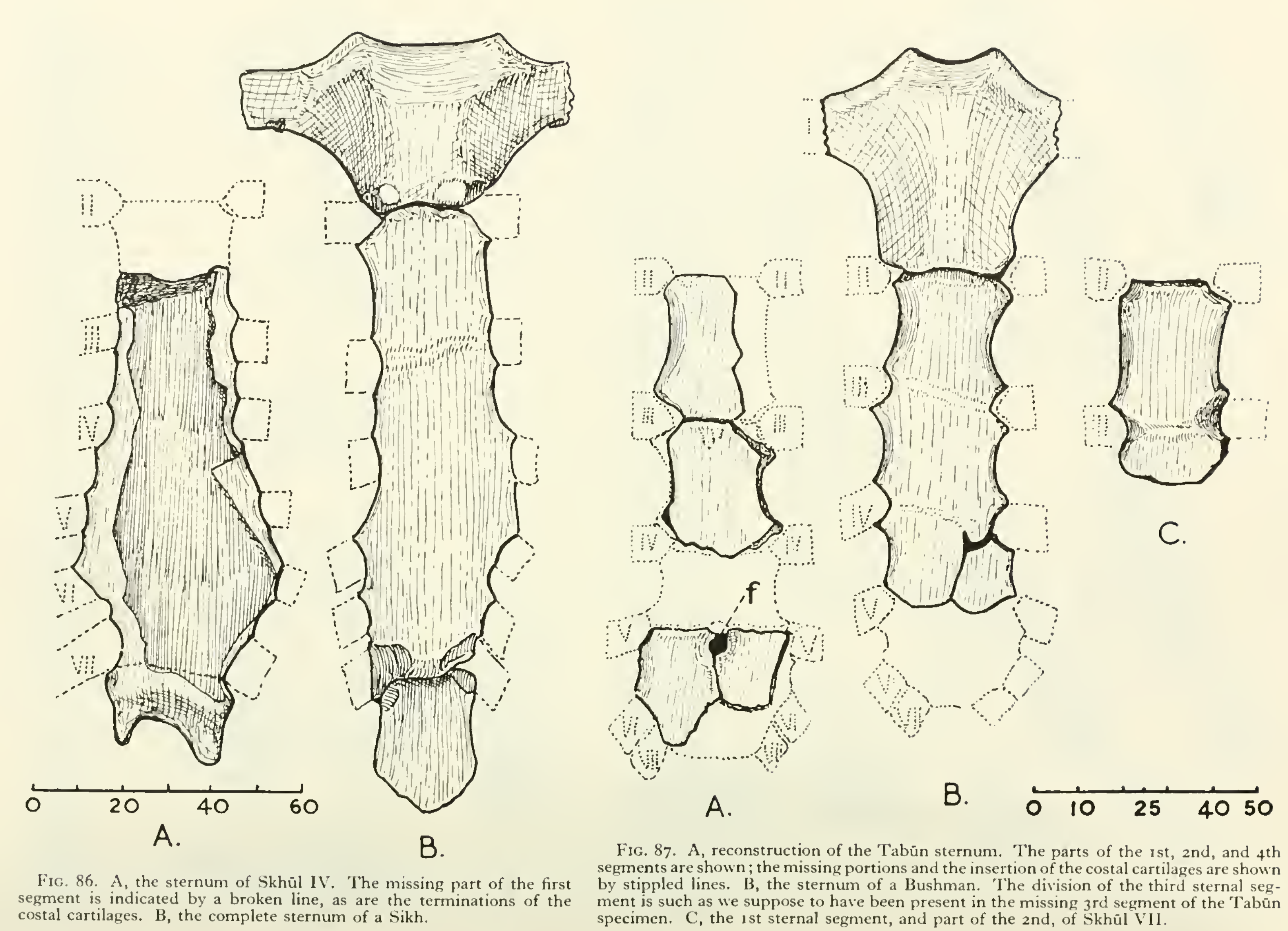


Fig. 86. A, the sternum of Skhūl IV. The missing part of the first segment is indicated by a broken line, as are the terminations of the costal cartilages. B, the complete sternum of a Sikh.

Fig. 87. A, reconstruction of the Tabūn sternum. The parts of the 1st, 2nd, and 4th segments are shown; the missing portions and the insertion of the costal cartilages are shown by stippled lines. B, the sternum of a Bushman. The division of the third sternal segment is such as we suppose to have been present in the missing 3rd segment of the Tabūn specimen. C, the 1st sternal segment, and part of the 2nd, of Skhūl VII.

CHAPTER IX

SHOULDER GIRDLE

SCAPULA (Pl. XXVIII D, E; Figs. 88–94)

THE following is a list of the specimens from Mount Carmel:

Skhūl IV. Right scapula: missing. Left scapula: portions missing, namely the greater part of the glenoid cavity, part of the superior (cranial) border and bits of the acromion and the entire coracoid. (Fig. 89; Pl. XXVIII E.)

Skhūl V. The left scapula is almost complete (Fig. 88). The right scapula is devoid of the glenoid and the acromion but the detached coracoid is present; the vertebral border of the infra-spinous segment is lacking.

Skhūl IX. The left scapula is represented by two fragments, one forming the lateral (glenoid) part of the spine, the other a segment of the axillary border. Both of these fragments show that the scapula of this individual was strong and massive, equal in dimensions to that of Skhūl V, the tallest man in our series.

Tabūn I. Left scapula (Figs. 90, 94; Pl. XXVIII D): the glenoid cavity, the axillary border and lower angle, the acromion and coracoid are present; the body and the entire vertebral border are missing (Fig. 90). The right scapula was not found.

This relatively full series has given us the basis for making a more detailed study of the Palaeoanthropic scapula than has been found possible hitherto. The fragment of the right scapula found at Neanderthal is one of the most instructive specimens which has come to light so far. We had a cast of this specimen at our disposal and made a fresh examination of its characters (Figs. 90, 92, 93).

Although fragments of twelve scapulae were found at Krapina only two were sufficiently complete to give comparative data. The scapulae of La Chapelle man were only fragmentarily represented, but Boule had at his disposal those of the two La Ferrassie skeletons, the scapula of one (La Ferrassie I) being nearly complete. Only fragments were found at Spy.

The Scapula as a whole.

In Fig. 88 A, B we reproduce a dorsal view of the left scapula of the tall man, Skhūl V (stature 1,786 mm.), side by side with that of a modern man, a Sikh (stature 1,666 mm.). As will be seen from Table XXXVI (p. 144), their main dimensions and shape are not greatly different. Their width is practically the same (162 mm. and 161 mm.), but the modern bone has the greater length or height, measured from the glenoid cavity to the vertebral border. The ratio of length to width (scapular index) is 63·2 in the ancient and 68·9 in the modern. It is apparently the rule for the scapula to be relatively short (or narrow) in Palaeoanthropic races. In Skhūl IV with a particularly narrow and scaphoid scapula (Fig. 89) the ratio is only 54·7. Even in the Australian scapula the index is 67. Unfortunately we cannot say how the Palestinians stand to the European Neanderthalians in this matter, there being no data. According to Martin (1928, vol. ii, p. 1096) the range of this index in modern races is from 60·3 in Tasmanians, 65·2 in Europeans, to 72·5 among the Senoi and Semang.

We have given particular attention to the axillary border of the scapula, its length, strength, and other characteristics. Our reasons for this special study are (1) that it is a relatively indestructible part and therefore more frequently preserved in ancient burials; (2) it is the bearer of certain racial characters; (3) we regard it as the main lever of the scapular system, providing the means by which the most powerful part of the serratus magnus may rotate the shoulder and raise the forelimb on the body.

The length of the axillary border is given in Table XXXVI (p. 144). This border is relatively short in the Skhūl people; in V, the tallest man, it is 134 mm. which is 82·6 per cent. of the width. In IV it is approximately 130 mm., 74·7 per cent. of the width. The corresponding lengths and percentages for the scapula of an Australian aboriginal are 123 mm., 85 per cent.; for the Sikh scapula, 140 mm., 86·9 per cent.; for a Bushman, 199 mm., 94·6 per cent.; for a chimpanzee 128 mm., 98·6 per cent. The absolute and relative length of the axillary border is low in the Skhūl people. In the Tabūn woman the length is 115 mm., 4 mm. less than in the Bushman, but the tabular part of the bone being missing, we cannot say what its proportion to the other dimensions was, but clearly it was low. In a tall Cromagnon (Barma Grande 2) recorded by Verneau, the axillary border exceeded our measurements, being 150 mm., which represents 70 per cent. of the scapular width, thus having a lower ratio than in our Skhūl scapulae and indicative of a relatively small scapular height in the Cromagnons.

It is of interest to ascertain the proportional development of the axillary border to the maximum length of the humerus; in Skhūl V it is 34·8 per cent. of the humeral length, in Skhūl IV 36·3 per cent., and in the Australian 36·7 per cent. The humeral ratio rises to 40 per cent. in the Tabūn woman; we estimate that the length of the axillary border in the Neanderthal scapula was 130 mm., giving a ratio of 41·1 per cent., nearly the same as in the Tabūn specimen. But in the Sikh, who had limbs which were relatively long for his trunk, the ratio is even higher, 42·4 per cent., which cautions us against attaching racial importance to the scapulo-humeral ratio. In the tall Barma Grande No. 2 individual the axillary border was 42·3 per cent. of the humeral length. The Palestinian axillary border is clearly a short one.

On the other hand, if we take femoral length as indicative of stature we find a steady relationship of axillary border to height of body. What we may speak of as the scapulo-femoral index runs as follows: Skhūl V, 25·8 per cent.; Skhūl IV, 28·3 per cent.; Tabūn I, 27·5 per cent.; Neanderthal, 27·1 per cent.; Sikh, 30·8 per cent.; Australian, 26 per cent.; Barma Grande 2, 30·4 per cent.

A consideration of the other scapular measurements elicited no other distinctive feature in the fossil scapulae. The ratio of the supra-spinous to the infra-spinous part of the vertebral border (Table XXXVI, p. 144) is variable, being low in Skhūl V and high in Skhūl IV. This difference may be due to the fact that the scapula of Skhūl IV is markedly hollow along the infra-spinous part of the vertebral border. It is a marked instance of the scaphoid type of scapula (Fig. 89 and Pl. XXVIII E); this character is to be regarded not as a character of race but as an individual variation.

Dimensions and Relations of the Glenoid Cavity.

A well-known character of the Neanderthal type of Europe is the absolute and relative massiveness of all their joint cavities and surfaces. A glance at Table XXXVII (p. 144)

will show that in this respect the Neanderthal glenoid measurements exceed those of the much taller Skhūl man, No. V. In the shape and dimensions of the shoulder-joint the Palestinians are Neanthropic or modern. Indeed, those of the Tabūn woman approximate to the measurements found in a Bushman and in a chimpanzee. The Tabūn scapula is the only one of our specimens which has an intact glenoid region. The Krapina specimens show a wide range of diameters—varying from 30 to 38·5 mm. in the longer axis and from 19 to 26 mm. in the transverse or shorter one. In the tall Cromagnons the long diameter reached as much as 44 mm.

As is well known, the glenoid cavity of the Neanderthal scapula is directed backwards (dorsally) to an unusual degree (Fig. 90 A). But when we wish to measure this degree and compare it with the retroversion of the glenoid surface in our specimen there is no standard base from which to measure. Our mode of orientation of the scapula is best made clear by first defining the basal plane, represented by the infra-spinous part of the scapular plate. In making the drawings and when measuring angles we place the scapula on a drawing-board covered with millimetre paper so that the bone rests on three supports of plasticine of equal height. One is placed under the anterior or ventral lip of the glenoid cavity, another under the extreme point of the inferior scapular angle, and the third under the vertebral border so that the basal end of the scapular spine is directly over it. The scapulae as seen in Figs. 91 and 92 rest on this infra-spinous (horizontal) plane (P–Q). The dorsal view of the scapula (Figs. 88–90) is drawn at right angles to the infra-spinous plane where the vertical (x–x) and transverse (w–w) axes are also shown. The first of these passes from the axillary lip of the glenoid to the mid-point of the inferior angle; the transverse axis intersects the vertical at right angles, at the axillary lip of the glenoid cavity. The axillary or lateral views of the bone (Figs. 91, 92) are drawn at right angles to the vertical plane or axis.

The scapula having been placed in this standard position, we measured the angle[1] formed by the intersection of the transverse axis or plane of the glenoid cavity with the infra-spinous plane. In the Neanderthal scapula the angle so formed is 61°, that is, the glenoid cavity has turned dorsally, from a position of 90° to the horizontal plane, to an extent of 29°. In Table XXXVII (p. 144) we give our results in terms of the dorsal deflexion from the direct lateral position (90° to the horizontal). In Tabūn I, for example, the deflexion is about 2–3°; in Skhūl V (with damaged glenoid) the deflexion is estimated to have been 16° while in the other specimens it ranged from 8° to 11°. We regard the great deflexion of the Neanderthal scapula as an extreme individual variation and we must also note that the relation of the spinous process to the glenoid is peculiar (Fig. 90 A).

The long a is of the glenoid forms an angle with the long (our 'vertical') axis of the axillary border, the axillo-glenoid angle. This is indicated in the drawing of the Sikh scapula in Fig. 88 B, $A°$. In the chimpanzee the glenoid is directed upwards to an unusual degree, so that the angle formed by the glenoid with the axillary border is 118°. The angle is high in the Neanderthal scapula, *c.* 145°, the glenoid forming a more obtuse angle with respect to the axillary border. Kramberger found this angle to vary from 139° to 146° in the Krapina scapulae. The angle appears to be a variable one in modern man, but the Palestinian figures are Neanthropic and not Palaeoanthropic. When the scapula

[1] This and the other scapular angles were projected on to the relevant vertical or horizontal planes and measured with a protractor.

is viewed from the front it will be seen that the long axis of the glenoid cavity also forms an obtuse angle with the infra-spinous plane (Fig. 91 A, $B°$). The long axis of the glenoid is directed dorsally as it passes downwards, thus forming an angle with the axillary border and the infra-spinous plane, an angle which is open upwards and dorsally. This angle, as may be seen in Table XXXVII, line 6 (p. 144), is variable. In the Sikh it is 180°, for the glenoid axis is parallel to the infra-spinous plane. It is about 169° in the Neanderthal scapula and in Tabūn I it is 174°.

Another feature of the glenoid cavity of the Neanderthal scapula is a central pit or excavation. This has been noted in other European specimens of Neanderthal man. The pit is not present in Tabūn I and there is no trace of it in Skhūl V, these being the only two Palestinian specimens with approximately complete glenoid cavities.

Spinous Process.

Unfortunately in none of our scapulae is the spinous process complete, yet in several estimates can be made of the total length, and direct measurement of the base in nearly all. In Table XXXVIII (p. 145) we give a list of the measurements made. It is clear that in total length of spine our Skhūl specimens are comparable to those found in Australian aborigines; they certainly fall far short of those which obtain for the Sikh. In the case of the Tabūn woman, the indications lead us to compare her dimensions of spine with those of the Bushman and chimpanzee.

In Table XXXVIII (p. 145) are given the 'heights' of the spine, taken between the points defined in a note appended to the table of measurements. The spine of the Neanderthal scapula, as it passes outwards over the glenoid, is very robust (12 mm. thick and 20 mm. wide) and high, its height as measured being 43 mm. In two of the Skhūl men (V, IX) the height was almost equally great and the process almost equally strong. In Skhūl IV the height—35 mm.—is the same as in the Australian. In Tabūn I the height is only 30 mm., 2 mm. less than in the Bushman and the diameters at the upper point of measurement (9 × 15 mm.) are less than those of the Bushman (10 × 17 mm.). The glenoid margin of the spine (Table XXXVIII, line 4) in Skhūl V is thicker when measured at its mid-point than is the original Neanderthal specimen although the latter is extremely thick at its attachment to the scapula.

In Table XXXVIII, lines 5, 6 (p. 145) we give other data bearing on the relationship of the spine of the scapula to the body of the bone. The spine may be attached to the scapula at a varying degree of obliquity. We measured the angle which the line of attachment of the spine forms with our vertical plane (Fig. 88 B, $C°$). As will be seen from Table XXXVIII, the spino-axillary angle varied from 51° to 56° amongst the Palestinians. It reached a much higher figure in the Neanderthal scapula, namely 58°, and a much lower one in a Bushman. In the chimpanzee the low figure of 20° is reached, the spine being set obliquely in connexion with a brachiating mode of locomotion.

Likewise we measured the angle which the spine of the scapula forms with the infra-spinous plane. This we took at the free or glenoid margin of the spine, the scapula having been placed in our standard position (Fig. 91 B, $D°$). The angle which the spine forms with the infra-spinous plane varies greatly. The spine may be deflected upwards (in a cranial direction) so that it masks or hides the upper margin of the scapula when the bone is viewed on its dorsal aspect. This was noted by Kramberger in the Krapina specimens;

it is also the case in the Skhūl specimens in which the spino-infra-spinous angle is wide, varying from 136° to 140°. In the Tabūn scapula, on the other hand, the angle is small—125°. It is small in the chimpanzee but is large in the Bushman, while in the Neanderthal scapula this angle measures 137°. In the Palaeoanthropic scapula the spine tends to be deflected upwards, in a cranial direction, but there are exceptions. Nor do we see clearly the functional significance of the spino-infra-spinous angle.

We measured the angle which the supra-spinous part of the scapula makes with the infra-spinous portion, measuring this at the vertebral border of the bone (Table XXXVIII, p. 145). Unfortunately it is impossible to make comparisons with Neanderthal bones, this region being defective in the known specimens. The Palestinian specimens come closest to the values for Bushman and Australian and exceed that of the Sikh, a relationship similar to the one which obtains for the spino-infra-spinous angle.

Morphology of the Axillary Border.

If readers will turn to Fig. 90 A they will observe on the axillary margin of the Neanderthal scapula a long shallow groove which we propose to name the marginal sulcus of the axillary border (Fig. 90 A, *c*; Pl. XXVIII D). Boule has called attention to it, finding it clearly and strongly marked in Neanderthal specimens from western Europe and we may appropriately refer to it as 'Boule's sulcus'. Of two Krapina specimens, one (No. 2, left) has it, while in the other (No. 1, right) it is absent, the condition in the latter being as in modern scapulae (Kramberger, 1906, Plate VIII, Figs. 1, 2). As will be seen in Fig. 90 B, and better still in Fig. 92 B, the marginal sulcus is exceedingly well developed in the scapula of the Tabūn female. At first sight it appears to be absent in the Skhūl specimens, but an investigation of these and of other specimens made clear to us that incipient stages in development of this fossa were present and that to understand their origin it was necessary to clear up certain obscurities in the anatomy of the scapula.

In the axillary border of the human scapula there are two semi-submerged pillars or bars of bone, a dorsal axillary bar (Figs. 88, 89, 90, *b*), and a ventral bar (Figs. 91, 92, 93, 94, *g*). These bars vary in their relations to each other; in the state found in the anthropoids, for example, the dorsal is the more lateral. It forms the projecting margin (Fig. 93 A, *b*). But in the Neanderthal scapula it is not the dorsal but the ventral bar which is situated most laterally (Fig. 93 F, *g*). In the scapula of Skhūl V (Fig. 93, D) the thick rounded margin is made up of the fused bars, both lying in the same antero-posterior plane. This is also the condition in the Chancelade scapula. Thus we have three types of axillary border: first, and oldest, the dorsi-marginal type where the dorsal bar is the more lateral in position and forms the free edge or margin (Fig. 93, A, B). Secondly, we have the ventro-marginal type, in which the ventral bar is the more lateral and forms the margin, a late type of border (Fig. 93, E). Thirdly, there is the amphi-marginal condition where both bars are equally massed along the axillary border (Fig. 93 D).

We shall now trace the evolution of the marginal sulcus which reaches so high a development in the Tabūn and Neanderthal scapulae (Figs. 90, 92). If the reader refers to the condition in a Bushman scapula (Figs. 91 A, 93 B), the features of the dorsi-marginal type will readily be appreciated. There is no marginal fossa or trace of it. The infra-glenoid tubercle (for the long head of the triceps) is seen to be continuous with the dorsal

bar, which is continued downwards by the marginal crest until the area for the origin of the teres major is reached, where the marginal crest then sinks into the ventral margin. The marginal crest (Fig. 91, *h*) separates the dorsal muscles from the ventral or subscapular. The crest marks the attachment of the fibrous septum which separates these two groups of muscles.

In the scapula of a Sikh (Fig. 91 B) it will be seen that the marginal crest has become deflected ventrally to a certain degree, exposing the dorsal bar above it. Why the marginal septum should be shifted ventrally we do not know, but it leads to an enlargement of the area from which the infra-spinous muscle arises. In the Sikh's scapula the marginal crest soon returns to the dorsal bar. The marginal sulcus is represented by a short, narrow groove (Fig. 91 B, *c*).

In Skhūl V (Fig. 91 C) we observe a further extension ventrally of the marginal crest and the area of infra-spinatus origin. The dorsal bar (*b*) is now freely exposed and the marginal sulcus extends backwards to the area for the origin of teres minor (*x*). The subscapular origin still covers the whole extent of the ventral bar.

The marginal sulcus in the Neanderthal and the Tabūn scapulae (Fig. 91) is fully developed. The marginal crest has reached the ventral bar and an extension ventrally of the infra-spinatus has taken place at the expense of the subscapularis origin as far back as the origin for teres minor. Behind the teres minor area (Fig. 91, *k*), the subscapularis still retains its ancient dorsal extension. A glance at Figs. 88–92, *k*, will show this extension of the subscapularis in the scapula of man and of all the higher primates.

Thus the marginal sulcus is not a heritage from an anthropoid stage but a late and specialized human acquisition, the functional significance of which remains obscure. We find incipient stages on Neanthropic and modern scapulae, but its full-blown stage is confined, so far as we can learn, to the Neanderthal or Palaeoanthropic group of mankind. In the Palestinian group we find all stages. Although the axillary border remains intact in only one short segment of the scapula of Skhūl IV, there is sufficient to indicate that there was a mere incipient stage, very similar to that described in the scapula of the Sikh (Fig. 91 B). There is also a fragment of the axillary border (distal to the mid-point) of the scapula of Skhūl IX. It is thick and strong, very like that of Skhūl V, and the marginal groove was developed to about the same extent as in Skhūl V. Thus we have in our Palestinian scapulae a series which bridge the gap which exists between the state found in the western European Neanderthalian and that which prevails among modern races. The modern condition represents the old or anthropoid condition, while the marginal fossa of Neanderthal man is an evolved and later acquisition. The Krapina people, who are akin to the Palestinians in so many points of structure, also show transitional forms in the axillary borders of their scapulae.

The axillary border of the Neanderthal scapula is particularly massive and strong. We took three measurements of its thickness, at a point 30 mm. distal to the glenoid, at the mid-point of the border, and at a distal point at the origin of the upper fibres of the teres major. The thickness in the Neanderthal scapula at these three points were 16, 12·5, 8 mm. The corresponding figures for Skhūl V are 16, 12·5, 8 mm.; for Skhūl IX (mid-point), 11·5 mm.; Skhūl IV (proximal point), 14 mm.; Tabūn I, 12, 10, 4 mm.; Australian, 11, 8, 6 mm.; Bushman, 11, 10·5, 6·5 mm.; Sikh, 11, 10, 7·5 mm.

Acromion Process.

In only one instance is this process complete, that of Tabūn I. The clavicular facet is situated on its medial margin, is oval in shape, measures 6 × 13 mm., and is set obliquely so that it looks upwards as well as backwards towards the median plane of the body (Fig. 90 B). The acromial outline is oblong, measuring 22 × 40 mm. It is 6 mm. thick. It shows no point in relative size or of shape which differentiates it from the acromion of an Australian aborigine (Figs. 90 B, 92, and 94). Boule found the acromion of La Ferrassie I to be narrow, having a width of 13–14 mm. On the other hand the Cromagnon acromion is wide, attaining as much as 34 mm.

The only other specimen at our disposal is that in the scapula of Skhūl IV (Fig. 89 A). The tip of the process, about 10–12 mm. in extent, is missing, but there still remains on its medial margin a portion of the facet for the clavicle (Fig. 89 A, *c. a.*). The acromion in this case is relatively small, being comparable to the state found in the scapula of a male Australian. Its width is 26 mm., it is only 5 mm. thick and its original length was probably 38 mm. In the Sikh's scapula the acromion is 30 mm. wide and 48 mm. long; in the Australian, 25 × 43 mm.

Coracoid Process.

The only complete specimen is on the scapula of the Tabūn woman (Figs. 92, 94). It shows several peculiarities not found in the coracoid of modern scapulae. In the first place there is the manner of its origin from the upper border of the glenoid and adjacent part of the supra-scapular margin. The glenoid root begins as a thickening on the hinder lip of the glenoid and runs upwards as a rounded ridge to end on what may be called the conoid tubercle, a strong tubercle situated on the marginal (proximal) angle of the horizontal part of the process. This angle separates the supra-spinous margin from the anterior glenoid. Although only the fractured root of the coracoid remains in the Neanderthal scapula, it is clear that on it there was a similar post-glenoid root to the coracoid. The flattened vertical root of the coracoid in the Tabūn specimen is only 22 mm. wide and 7 mm. thick. The corresponding diameters in the Neanderthal specimen were 27 × 13 mm., much stronger and longer than in the Tabūn female. In Skhūl V the corresponding measurements of the root of the coracoid are only 22 × 10 mm. In a Sikh's scapula these measurements are 26 × 12·5 mm.; in an Australian, 23 × 10 mm., almost identical with Skhūl V. This measurement in the Krapina specimens ranged from 20·2 to 21·4 mm. in width and from 7·5 to 10 mm. in thickness, corresponding closely to the Palestinian measurements.

The horizontal process of the coracoid, in the scapula of Tabūn I, is 35 mm. long and 12 mm. wide; corresponding measurements in a male Australian are 42 × 13 mm. The ligamentous markings are different; in the Australian there is a massive tubercle at the medial end of the trapezoid ridge, just above the lateral wall of the scapular notch, for attachment of the conoid ligament. There is no such thickening or conoid tubercle on the crescentic trapezoid ridge in Tabūn I (Fig. 94, *trap*), but on the other hand there is a prominent angular tubercle situated on the anterior margin, just above the glenoid root (Fig. 92 B, *y*). This serves for the attachment of the coraco-acromial ligament.

We have also a fragment of the coracoid which had formed part of the right scapula of Skhūl V. It represents the greater part of the horizontal limb of the coracoid, only

its tip being missing. The markings for the coraco-clavicular ligaments, the trapezoid and the conoid, are as in the modern coracoid, quite different from those seen in the same part of the Tabūn scapula. The original length of the horizontal limb in Skhūl V must have been about 45 mm., its width 16 mm., and its thickness 8·5 mm. The measurements are in the closest agreement with those in the coracoid of a Sikh's scapula. In the two Krapina specimens the widths were 14·6 and 12·5 mm. narrower than ours and less in thickness (6 and 6·5 mm.).

Scapular Notch.

Fortunately the floor of this notch is preserved on the upper margin of the left scapula of Skhūl V and is of the modern small type. The part preserved has a width of only 6 mm., identical to the notch in the Sikh scapula. This incisure is preserved in a Krapina scapula and also in one of the La Ferrassie specimens. It is wide and shallow as in apes and several living primitive races (Australian, Bushman).

The condition of the notch in the Tabūn scapula is open to doubt. In Fig. 94 it will be seen that the root of the coracoid has been broken and the supra-scapular margin crushed. There is, however, at the bottom of the fissure shown in Fig. 94, *f*, a rounded notch with smooth margins which we take to be the floor of the incisure. If so, and we are persuaded that this is the case, the form of the incisure was that found in the scapula of modern races, and not the open-bay type seen in the anthropoid scapula (Fig. 89 B, *n*).

Summary.

The Skhūl men had scapulae which were small relative to their stature, corresponding to the development of limb and shoulder girdle found in Australian aborigines. The scapula was also narrow relative to its height (cranio-caudal diameter), which is also the case in the scapula of the Australian. The scapulae of the tall Cromagnon men were also relatively narrow, but the glenoid cavity, the spine, and the acromion were more robustly developed than in the Skhūl men. In the majority of its characters the Skhūl scapula shows no structural point which definitely separates it from the scapula of modern races. In some features, such as in the transition of the spine to the acromion, the condition agrees with that found in the Neanderthal scapula. Like that scapula, the Skhūl specimens have very robust and thick axillary borders.

The most puzzling issue of our study of the scapula concerns the position we are to assign to the Tabūn woman. Does she represent an extreme variant of the Skhūl type, or does she represent a different but allied stock? The evidence of the scapula presses us towards the latter supposition. There is the extreme development of Boule's sulcus, a feature characteristic of the scapula of the western Neanderthal type of Europe. This is not a constant feature of the Krapina individuals; transitional types linking them to the condition seen in the modern scapula do occur. This is also the case in the Skhūl scapulae. Besides, we find incipient stages in the development of a marginal sulcus in the modern scapula. The marginal groove is not an anthropoid feature but is a new and recently evolved character and its presence may not imply more than a variation in certain races. It is undoubtedly a Neanderthal character and for that reason we must regard the Palestinians as of the same group as the Neanderthalians of Europe.

It is when we consider the fact that the Skhūl coracoid carries modern characters,

while the Tabūn specimen carries features which must be deemed distinctive, that we are moved to separate the Tabūn type from the Skhūl form. This is a problem which occurs again and again as we survey and compare the various bones of the limbs. There can be no doubt, however, that the Palestinians, both the Skhūl and the Tabūn types, are nearer akin to the modern races than to the Neanderthal type of Europe.

THE CLAVICLE (Figs. 95–8; Pl. X)

The list of the parts at our disposal is as follows:

Tabūn I. Right: medial or sternal part, 59 mm. in length. The sternal articulation is damaged (Fig. 98), and bears the tooth marks of a small carnivore or rodent. The original length of the clavicle was probably between 135–140 mm.: a slender bone of peculiar shape. There is also a fragment of the extreme acromial end of the shaft, 21 mm. long. At its articular (acromial) end the vertical diameter becomes 11 mm., showing the thickening found at the acromial end of Neanderthal clavicles.

Left: two fragments, one representing the medial end and part of the shaft (62 mm.), the other the junction of the cylindrical and the lateral (or outer flattened acromial) segment, 32 mm. in length.

Skhūl I. See Chapter XX.

Skhūl IV. Right: a fragment of the sternal end, 35 mm. in length. Another fragment representing a portion of the middle part of the shaft giving origin to the pectoralis major, 50 mm. in extent.

Left: medial or sternal half, 74 mm. in extent (Fig. 97). The original length of this stout bone must have been about 152 mm.

Skhūl V. Right: almost complete (Figs. 95, 96). Left: extremities missing; 134 mm. preserved. Both are stout bones, with an original length of about 154 mm.

Skhūl VI. Sternal part of the left bone, measuring 88 mm. The original length was probably 150 mm. The sternal part of the first rib is cemented to the under surface of the clavicle.

For comparison with these we had an excellent cast of the right clavicle of the Neanderthal skeleton and excellent photographs of the two clavicles from Krapina which Kramberger (1906) reproduced in Plate VIII, No. 4 being of a woman and No. 5 of a man. To represent modern races we have used the clavicles of the three skeletons mentioned previously in this monograph, a Sikh, an Australian, and a Bushman.

Boule describes and figures a fragment of the left clavicle of La Chapelle man and mentions that the La Ferrassie clavicles are complete, being long, slender and curved, presenting certain resemblances to the clavicle of the chimpanzee. Altogether, fragments of 21 clavicles were found at Krapina. A clavicle was found at Spy, attributed to No. 1. It, too, is slender. Dr. Hrdlička (1930) gives notes on all of these specimens.

Kramberger was struck by the variability shown by the Krapina clavicles and descriptions given by other anatomists emphasize the plastic nature of this bone. All the published descriptions have left us in doubt as to the essential characters of the bones described and we have found it necessary to resort to drawings and sections (Figs. 95, 96) in order that others may appreciate the features of the clavicles found at Mount Carmel, and remain in no doubt as to how they compare with the Neanderthal types of Europe

and with representatives of modern races. We have found it necessary to devise a method of orientation so that comparison of bone to bone may be possible.

Our chief difficulty was to find what may be regarded as a relatively fixed or constant surface. We came to the conclusion that the area to which the subclavius muscle is inserted came nearest to such a surface. In Fig. 95 the clavicles are represented in this plane. We are to speak of the clavicle as if it were viewed from in front, in a man standing erect. We found that the anterior and posterior borders of the groove for the subclavian insertion gave us an approximate plane for orientation in this direction (sections, Fig. 96, *O–O*). In the Palestinian clavicles, as in the modern, and we suspect that the same is true of the Krapina clavicles, the whole extent of the bone lies above the subclavian plane, except the medial or sternal end. In the Neanderthal clavicle the acromial end dips below this plane (Fig. 96 B).

For a second or coronal plane we found that the best was the chord which joins the ends of the greater or forward curvature (Fig. 95, *P–P*). In all our drawings and descriptions we suppose that the specimens are viewed and measured in the manner of orientation just described. The outer or acromial end cannot be used for our purpose because it is subject to possible torsion in relationship with the more fixed sternal moiety.

Length.

The lengths are given in Table XXXIX (p. 145). In modern races the means for length in the male clavicle vary from 140 to 155 mm., the highest figure given being that for Patagonians. In Egyptian males, who are of medium stature, the mean length is 152 mm., so that there is no close correlation between clavicular length and stature. In our tallest man (Skhūl V) the length is 154 mm. Unfortunately all the other specimens were incomplete, but we are convinced that in Skhūl IV and Skhūl VI, both males, the lengths were somewhat less, 150–152 mm. In the Neanderthal (Düsseldorf) man the length was probably 150 mm. and in a Krapina male, a fraction less. In spite of their tallness our men were evidently no broader in the shoulders than were the much shorter Neanderthalians of Europe. This is in keeping with their scapulae which were moderate in size.

Robusticity.

The Neanderthal clavicles are usually described as slender. When, however, we examine their index of robusticity, the ratio of the circumference at the mid-point to the maximum length, we find that our clavicles are robust and strong, and so is the original Neanderthal clavicle. The index of robusticity in the strong looking Sikh clavicle, for example, is 23·3. It rises to 24·4 in the Australian owing to his clavicle being absolutely and relatively short. It is only 21·1 in a Bushman. Martin gives a range of 22–7 in the indices for living races. In Skhūl V it rises to 26·9, practically the same as in the Neanderthal clavicle. The clavicles of Skhūl IV and Skhūl VI appear to have been equally as strong. If our estimate of length in the Tabūn woman is accepted (135 mm.), then her index of robusticity was 25. One has but to look at the extensive surface devoted to the origin of the pectoralis major in the clavicle of Skhūl V (Fig. 96 C) to see how enormously that muscle must have been developed. It extends outwards almost to the point at which the origin of the deltoid commences.

Curvature.

The great curvature of the Neanderthal clavicle has been remarked by all observers. The data relating to this feature are given in Table XXXIX (p. 145). It is remarkably great in the male clavicle figured by Kramberger, reaching an index of 15. The index of curvature in the Neanderthal specimen is 11·3; in Skhūl V it is 12. In the female Krapina clavicle it is 11·1, in the Sikh it is only 8·2, while in an Australian it is 11·6, and in a Bushman 10. Martin gives the height of the curvature as varying between 6 and 9 mm. in modern races (Bantu); in Skhūl V it is 13 mm.; in Neanderthal 12 mm. and in the male Krapina example, 15 mm.

As to the significance of the curvature, we are still in the dark. It must have to do with the form of the upper part of the thorax, the part formed by the upper four ribs. We infer that a great curvature in the clavicle indicates a rotundity (as contrasted with flatness) in the upper thorax.

Conformation of the Clavicle.

In discussing the anatomy of the clavicle it is necessary to recognize three segments, a long middle, a shorter sternal and an acromial segment, any one of which may vary independently of the other two. Measurements of these three segments at defined points are given in Table XL (p. 145) and are illustrated in Fig. 96 by representative sections. We shall consider first the middle segment, the region of the great curvature.

Clavicles, when examined in section such as those shown in Fig. 96, middle series, show two chief diameters—vertical and antero-posterior. Like skulls, clavicles may be divided into three kinds: platycleidic, when the antero-posterior diameter is equal to 120 per cent. or more of the vertical; acrocleidic or high clavicles, when the antero-posterior diameter is less than 80 per cent. of the vertical diameter; mesocleidic, when the ratio falls between 80 and 120 per cent. As will be seen from Table XL, line 6 (p. 145), the clavicle of Skhūl V in its middle segment has an index of 145. On the other hand, in the clavicle of Tabūn I the antero-posterior diameter is only 53·8 per cent. of the vertical diameter; it is acrocleidic.

As already mentioned, the clavicle of Skhūl V in its middle segment is very flat; so, too, is that of Skhūl VI. The clavicles of Tabūn I and of Skhūl IV, by contrast, are high and acrocleidic. The Neanderthal clavicle has an index of 108·3; it is mesocleidic. Most of the Krapina clavicles are platycleidic, the best preserved having an index of 129. The Australian and Bushman clavicles whose measurements are given in Table XL (p. 145) are platycleidic, that of the Sikh mesocleidic. The prevalence of flattening in the clavicles at Krapina and at Mount Carmel are notable facts. Especially are the absolute measurements noteworthy. Those of the Skhūl men are the highest, although closely approached by the Neanderthal clavicle.

We now turn to consider for a moment the sternal segment of the clavicle in the region where the sterno-cleido-mastoid muscle gains an insertion. Sections are shown in Fig. 96, right series, and measurements in Table XL, lines 1, 2 (p. 145). The most remarkable of all the specimens is the original Neanderthal clavicle (Fig. 96 B). The upper surface, as it approaches the sternal end, becomes raised to form a high sharp crest. Here the form is acrocleidic, the antero-posterior diameter forming 67·4 per cent. of the

vertical. A somewhat similar form is assumed by Tabūn I at the sternal end and the same feature is seen in the clavicle of La Chapelle. Although the conformation is different, the sternal end of Skhūl IV is also acrocleidic, the antero-posterior diameter being only 65 per cent. of the vertical. In Skhūl VI the cleidic index is 73·6, whereas in Skhūl V it is 106. In the Australian the flatness is extreme and it is also considerable in the Sikh. On the other hand, the clavicle of the Bushman is high in the mesocleidic group, its index being 91·6. We shall find that clavicles which are compressed from front to back in their sternal segments have a narrow and high articular surface at their sternal end, and those flattened from above downwards have flattened articular ends. We shall return to this point.

It is not necessary to discuss the features of the acromial end at any great length. Measurements are given in Table XL, lines 7, 8 (p. 145), and sections in Fig. 96, left series. The most peculiar acromial end is found in the Neanderthal clavicle (Fig. 96 C). In all forms the clavicle is platycleidic in its acromial segment, but the Neanderthal is the least so of known human clavicles. The antero-posterior diameter exceeds the vertical by only 20 per cent. whereas in many modern bones it is 100 per cent. or more; that is to say, the antero-posterior diameter is twice the vertical. Skhūl V has the acromial flattening of the modern clavicle. The Krapina clavicles are narrow and high in their acromial ends, as in the Neanderthal clavicle. This is also the case in the Tabūn clavicle, one of the many features which serve to link that skeleton to the Neanderthal type and to separate it from the Skhūl type.

The ratio of one diameter to the other is of importance; not less so are the absolute measurements which indicate the massiveness of the Skhūl clavicle. Those of the acromial end of the Neanderthal clavicle are also great. The contrasted sections shown in Fig. 96 of the Sikh, of Neanderthal, and of Skhūl V should be examined. The amount of the bone substance is approximately the same in all three. As is so often the case in these comparisons, the Skhūl type of section is intermediate between the Neanderthal and the modern types. A section of the acromial end of the Tabūn clavicle is shown in Fig. 96 E below that of the Bushman. It is remarkably small and approaches the Skhūl rather than the Neanderthal type.

Acromio-clavicular and Sterno-clavicular Joints.

The articular surface at the acromial end of the fossil clavicle is rarely complete. In Skhūl V the outer end of the bone is sufficiently intact to give measurements. It had a vertical diameter of 12 mm. and an antero-posterior diameter of 19·5 mm. In the Sikh the corresponding measurements are 11 and 21 mm. The Skhūl acromial joint is modern in its dimensions. The acromial articular end of the Krapina male clavicle (No. 5) had notable diameters; the vertical was 18·4 mm. and the antero-posterior 19·3 mm. The Neanderthal clavicle had, like all the Neanderthal long bones, massive articular extremities. In this respect the Skhūl clavicles are not Neanderthaloid but agree instead with the modern type.

In only one case were we able to restore the articular surface at the sternal end of the clavicle. As will be seen in Fig. 97 C, the sternal half of the left clavicle of Skhūl IV was preserved. Its articular surface is shown in Fig. 97 B. The drawing is a reconstruction made from both right and left bones, the area missing in the left being preserved in the

right bone. The dimensions are remarkable; 30 mm. in a vertical direction and 16·5 in a transverse. It is massive in size and its main axis is vertical. Beside it is placed a drawing of the sternal articular surface of a modern bone of large size. The latter's chief axis is in a transverse (oblique) direction, its measurements being 28 × 19 mm., rather larger than the area of the Skhūl bone. In the series of clavicles shown in Fig. 96, there is one of a Bushman (Fig. 96 D). In that specimen the sternal end has its long diameter placed vertically as in Skhūl IV. The functional significance of this alteration in the position and contour of the sternal end of the clavicle, from the vertical to the oblique position, we do not perceive. The two forms have been noted by previous writers.

We have marked a curious inlet or 'hilum' on the margin of the sternal articular surface (Figs. 95, 96, 97, *h*). It is always directed towards the cartilage of the first rib. In Skhūl IV it is at the lower anterior pole of the articular oval. In the modern articular surface it is situated near the middle of the long lower border. The significance of the hilum we leave undetermined. The sternal part of the Krapina clavicle (No. 5) also had its long diameter (25·5 mm.) in a vertical direction, while its transverse diameter was 18 mm., giving about the same area as in Skhūl IV.

In Fig. 98 C we depict the sternal end of the right clavicle of the Tabūn woman. It is the largest of the three fragments preserved. The upper border at the sternal end has been gnawed, but on the left side this border was preserved and has been reversed and transferred in outline to the right side. The border rises up into a sharp crest as in the original Neanderthal specimen. The bone is slender and acrocleidic. A transverse section of the shaft is shown in Fig. 98 B. In Fig. 98 A is shown the corresponding section of the clavicle of Skhūl VI (male); it, too, is of the acrocleidic type. Although slender, the Tabūn clavicle approaches the form seen in the Neanderthal specimen (Figs. 95, 96).

Claviculo-humeral Ratio.

According to the data tabulated in Martin's *Lehrbuch* (vol. ii, p. 1098) the ratio of clavicular to humeral length varies from 42·3 per cent. (male Australians) to 52·1 per cent. (male Patagonians). In one of the two La Ferrassie skeletons Boule found the ratio as high as 54 per cent. Only in Skhūl V have we intact bones to guide us. In this individual the ratio is only 40 per cent. If we take the reliable estimates for Skhūl IV we infer the ratio in this man to have been 42·4 per cent., the same as the mean index given by Martin for Australians. In the Australian used by us the ratio fell to 39·1 per cent. In the Neanderthal skeleton the ratio is 47·4 per cent., and by using the estimated length of the Tabūn clavicle, 135 mm., we obtain an index of 47, the same as in Neanderthal man. Here appears to be another point of resemblance. In the Sikh used for comparison the ratio is 46·6 per cent., almost as high as in the Neanderthal skeleton. The proportions of the clavicle to the humerus in the Skhūl men must have been very similar to what holds for modern Australians. In the Tabūn woman the ratio is Neanderthal and is also comparable to the indices in many living races.

As might be expected, the claviculo-femoral ratio is low in the Skhūl men. It is 29·7 in Skhūl V; 30·7 in Skhūl IV, rising to 32·2 in the Tabūn woman. The ratio for the Neanderthal skeleton is 34. In an Australian it falls to 27·7 but rises to 33·9 in a Sikh. The Skhūl men had not Neanderthal proportions.

Summary.

The Skhūl men were narrow between the shoulders when we take their stature into account. Yet their clavicles show very extensive muscular impressions, indicating strong shoulder muscles, and they were greatly curved, as in Neanderthal man, but in form and markings they differ greatly from the type specimen from Neanderthal. The Skhūl clavicle is essentially modern in type and yet we have amongst the Palestinians a range of forms which serves to link the highly characteristic clavicle of the Neanderthal skeleton to the type which prevails in modern races. The clavicle of the Tabūn woman is the most Neanderthaloid of the series. Indeed, if we had not transitional forms, as in the scapula, we should unhesitatingly regard its owner as a member of the true Neanderthal group. We are still left in doubt concerning her true status, whether she is really an extreme variant or the representative of a group which had strayed into a Skhūl community. The Krapina clavicles, certainly much less robust than those from the Skhūl, are also less modern in type, more akin to the true Neanderthal form. We are inclined to regard the Krapina type as intermediate to the Neanderthal type of western Europe and the more modern form found among the Skhūl men.

Table XXXVI. SCAPULA

	Skhūl IV	*Skhūl V*		*Tabūn I*	*Australian*	*Sikh*
	L	L	R	L	L	L
Width M 1	174·0	(162·0)	..	..	145·0	161·0
Length M 2	(95·0)	102·5	..	..	97·0	111·0
Scapular index	54·7	63·2	..	..	67·0	68·9
Length of axillary border M 3	(127·0)	(134·0)	..	115·0	123·0	140·0
Length of cranial border M 4	(81·0)	(81·0)	..	..	89·0	80·0
Length of vertebral border:						
infra-spinous part M 5a	117·0	(122·0)	..	..	108·0	120·0
supra-spinous part M 6a	66·0	(50·0)	(53·0)	..	47·0	60·0
Ratio: supra- to infra-spinous parts of vert. border	56·4	41·0	..	..	43·5	50·0

Table XXXVII. SCAPULA

	Neanderthal	*Tabūn I*	*Skhūl V*	*Australian*	*Sikh*	*Bushman*	*Chimp.*
	R	L	L	L	L	L	L
Glenoid cavity:							
vertical diameter M 12	38·0	29·0	(34·0)	32·0	35·0	29·0	27·0
width M 13	24·0	19·0	(23·0)	23·0	26·0	21·0	19·0
depth M 14	4·0	3·0	(2·0)	3·2	4·0	3·0	3·5
Angle:							
glenoid retroversion*	29°	2–3°	16°	11°	8°	11°	11°
axillo-glenoid†	145°	132°	127°	136°	125°	130°	118°
glenoid-infra-spinous plane‡	169°	174°	173°	160°	180°	162°	164°

* Angle formed by the transverse axis of the glenoid cavity with the infra-spinous plane of the scapula (p. 133).

† Angle formed by long axis of the glenoid cavity with the axis of the axillary border (Fig. 88 B, *A*°). Similar to Martin, 17.

‡ Angle formed by long axis of the glenoid cavity with the infra-spinous plane (p. 134 and Fig. 91 A, *B*°).

Table XXXVIII. SCAPULA

	Skhūl IV	*Skhūl V*		*Tabūn I*	*Skhūl IX*	*Neanderthal*	*Australian*	*Sikh*	*Bushman*	*Chimp.*
	L	L	R	L	L	R				
Length spinous process M 7	(127·0)	(132·0)	..	..	..	..	132·0	151·0	122·0	126·0
Spine:										
length of base M 8 . . .	77·0	83·0	(84·0)	..	..	..	82·0	94·0	71·0	78·0
height*	35·0	41·0	42·0	30·0	(42·0)	43·0	35·0	32·0	32·0	28·0
thickness at glenoid margin† .	9·0	10·5	9·5	7·2	10·0	9·0	8·4	9·0	9·2	8·0
Angle:										
Spino-axillary‡	52·0°	51·0°	(56·0°)	(55·0°)	..	58·0°	46·0°	54·0°	46·0°	20·0°
Spino-infra-spinous plane§ .	139·0°	136·0°	140·0°	125·0°	..	137·0°	134·0°	118·0°	140·0°	110·0°
Supra-spinous-infra-spinous .	142·0°	140·0°	..	..	..	..	145·0°	134·0°	146·0°	155·0°

* The distance measured from the bottom of the depression between the dorsal lip of the glenoid cavity and the glenoid margin of the spinal-base, to a point directly over the glenoid cavity, a point on the caudal margin of the acromion which would be intersected by the projection of the transverse axis of the glenoid cavity.

† Thickness of the glenoid margin of the spine, taken at the mid-point of the margin, 10 mm. inwards from the actual margin.

‡ The angle formed by the base of the spine with the axillary axis (Fig. 88 B, *C*°).

§ The angle formed by the free or glenoid margin of the spine with the infra-spinous plane (Fig. 91 B, *D*°).

Table XXXIX. CLAVICLE

	Tabūn I		*Skhūl IV*		*Skhūl V*		*Skhūl VI*	*Neanderthal*	*Krapina (5) male*	*Krapina (4) female*	*Sikh*	*Australian*	*Bushman*
	R	L	R	L	R	L	L	R	R	R	R	R	R
Length of part preserved . .	80·0	94·0	85·0	74·0	152·0	134·0	88·0	144·0	149·0	130·0	154·0	131·0	137·0
Maximum length M 1 . .	135·0	135·0	152·0	152·0	154·0	154·0	150·0	150·0	149·0	134·0	154·0	131·0	137·0
Circum. at mid-point M 6 . .	34·0	32·0	44·0	42·0	41·0	41·0	41·0	40·5	..	..	36·0	32·0	29·0
Index: length-thickness . .	..	..	..	27·6	26·9	26·9	27·3	27·0	..	..	23·3	24·4	21·1
Curvature:													
length of chord M 3 . .	..	..	..	..	108·0	..	..	106·0	100·0	90·0	112·0	86·0	100·0
height (subtense) M 2 . .	..	..	..	..	13·0	..	..	12·0	15·0	10·0	9·0	10·0	10·0
Index	..	..	..	..	12·0	..	..	11·3	15·0	11·1	8·8	11·6	10·0

*Table XL.** CLAVICLE

	Tabūn I		*Skhūl IV*		*Skhūl V*		*Skhūl VI*	*Neanderthal*	*Krapina 5*	*Sikh*	*Australian*	*Bushman*
	R	L	R	L	R	L	L	R	R	R	R	R
Diameters: (15 mm. from sternal end) .												
vertical (cranio-caudal)	15·0	15·0	..	20·0	12·0	..	19·0	17·5	..	13·0	12·0	12·0
sagittal (dorso-vent.)	12·0	11·0	..	13·0	18·0	..	14·0	13·0	..	15·0	19·0	11·0
Ratio: sagittal to vertical diam. . .	80·0	73·3	..	65·0	106·0	..	73·6	67·4	..	115·0	158·0	91·6
Diameters: (mid-pt. of length)												
vertical M 4	13·0	..	17·0	..	11·0	11·0	10·0	12·0	8·5	11·0	8·0	9·0
sagittal M 5	7·0	..	11·0	..	15·0	16·0	14·0	13·0	11·0	11·0	11·0	12·0
Ratio: sagittal to vertical diam. . .	53·8	..	64·7	..	136·0	145·0	140·0	108·3	129·0	100·0	137·0	133·0
Diameters: (acromial segment)												
vertical	..	7·0	..	..	10·0	..	..	12·5	11·1	9·0	8·0	8·0
sagittal	..	11·0	..	..	19·0	..	..	15·0	12·3	18·0	16·0	15·0
Ratio: sagittal to vertical diam. . .	..	157·0	..	..	190·0	..	..	120·0	110·0	200·0	200·0	187·0

* Sections in Fig. 96.



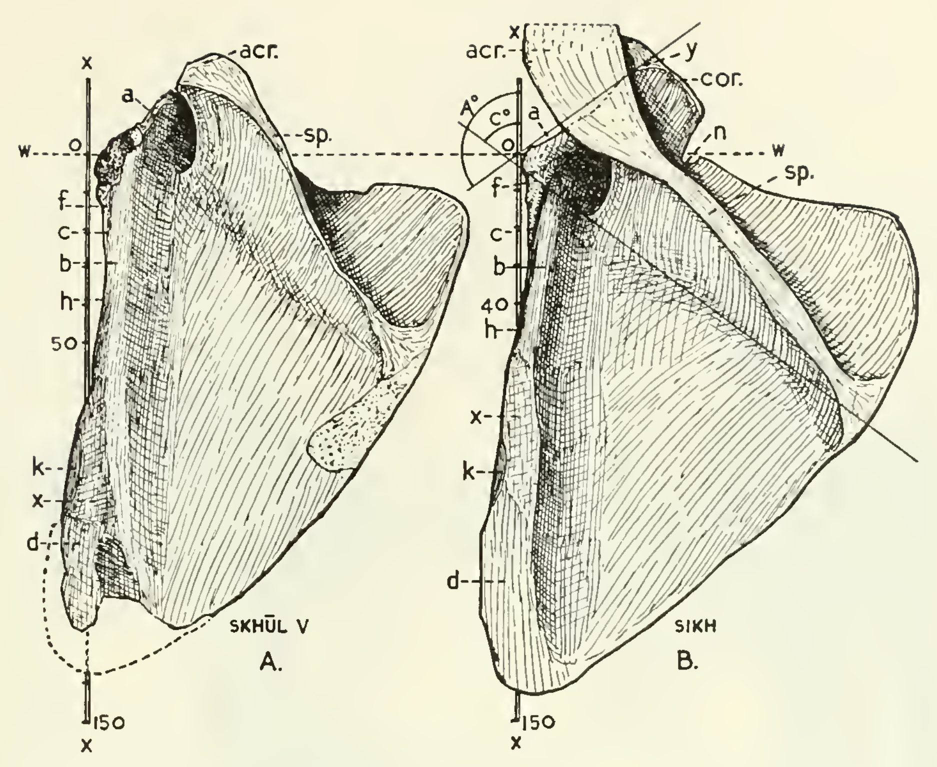


FIG. 88. THE SCAPULA, LEFT DORSAL ASPECT. A, Skhūl V; B, Sikh. The horizontal plane on which the specimens are orientated is explained on p. 133. In this figure the vertical plane (X–X) is represented by a double line passing from the axillary lip of the glenoid cavity to the lower angle of the scapula, and the transverse plane (W–W) is represented by a broken line crossing the vertical plane at a right angle at the axillary lip of the glenoid cavity. *a*, glenoid cavity; *acr.*, acromion; *b*, dorsal bar of the axillary margin; *c*, marginal sulcus; *cor.*, coracoid; *d*, origin of teres major; *f*, origin of the long head of the triceps; *h*, marginal crest; *k*, dorsal extension of the subscapular area; *n*, scapular notch; *sp.*, spine of scapula; *x*, origin of teres minor; *y*, angular tubercle of the coracoid (for coraco-acromial ligament). Certain angles indicated at the glenoid cavity (Fig. 88, B) are described in the text.

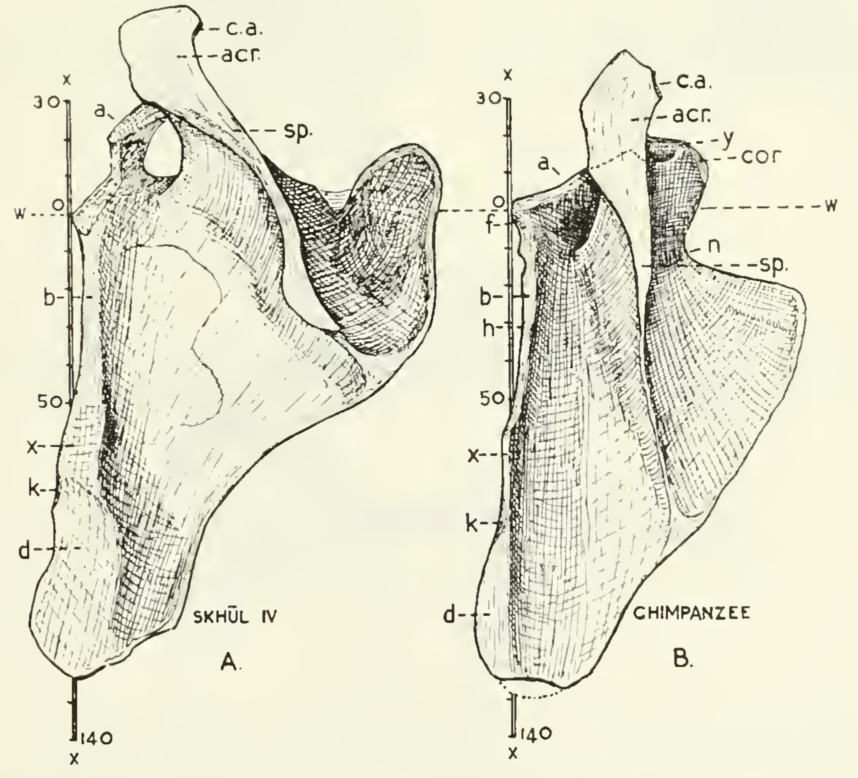


FIG. 89. THE SCAPULA, LEFT DORSAL ASPECT. A, Skhūl IV; B, Chimpanzee. The orientation and letters are as in Fig. 88. *c.a.*, clavicular facet on acromion.

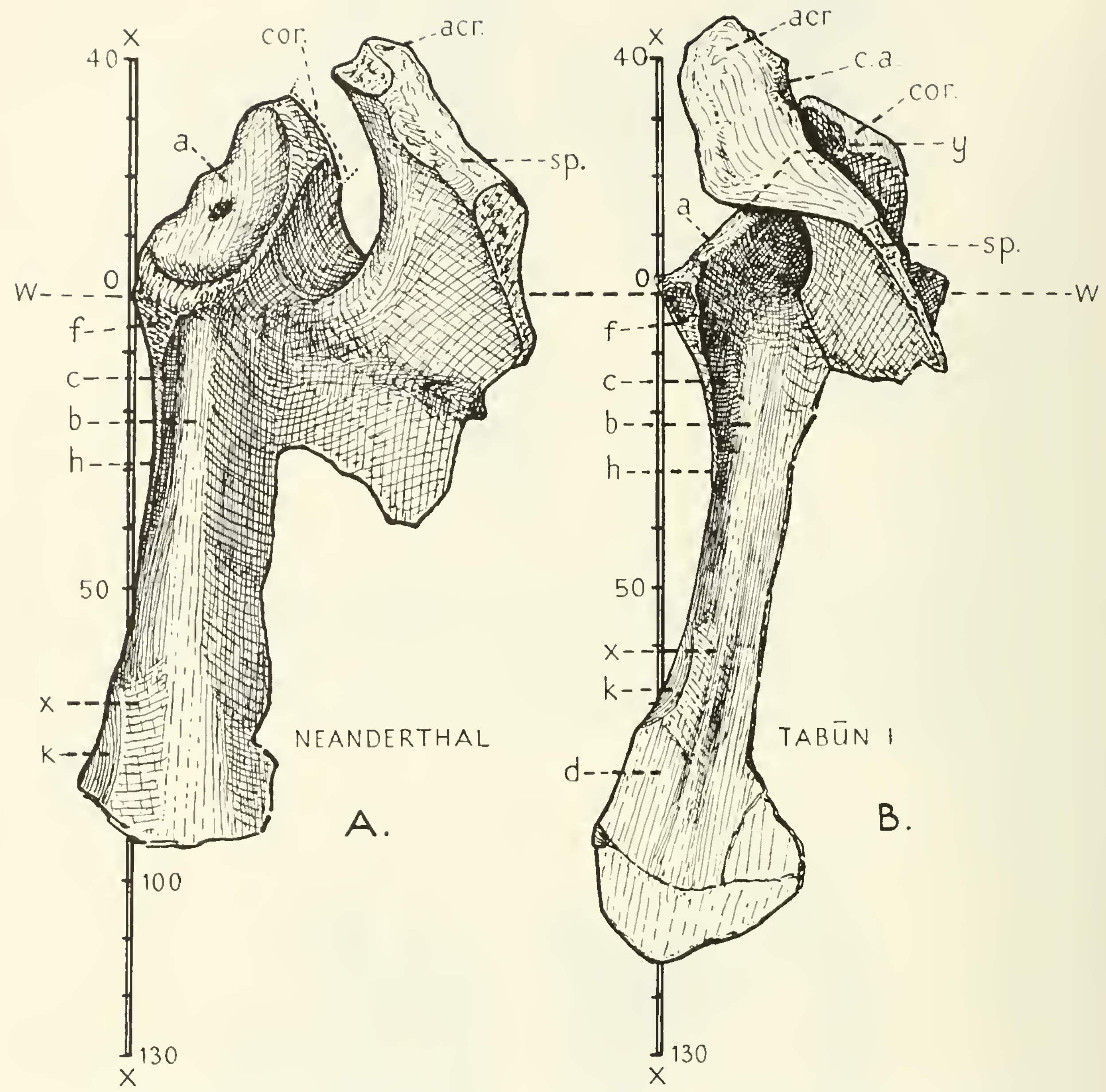


Fig. 90. The Scapula, Left Dorsal Aspect. A, Neanderthal (cast); B, Tabūn I. The orientation and letters are as in Figs. 88, 89. The broken line for attachment of the coracoid in the Neanderthal specimen is indicated.

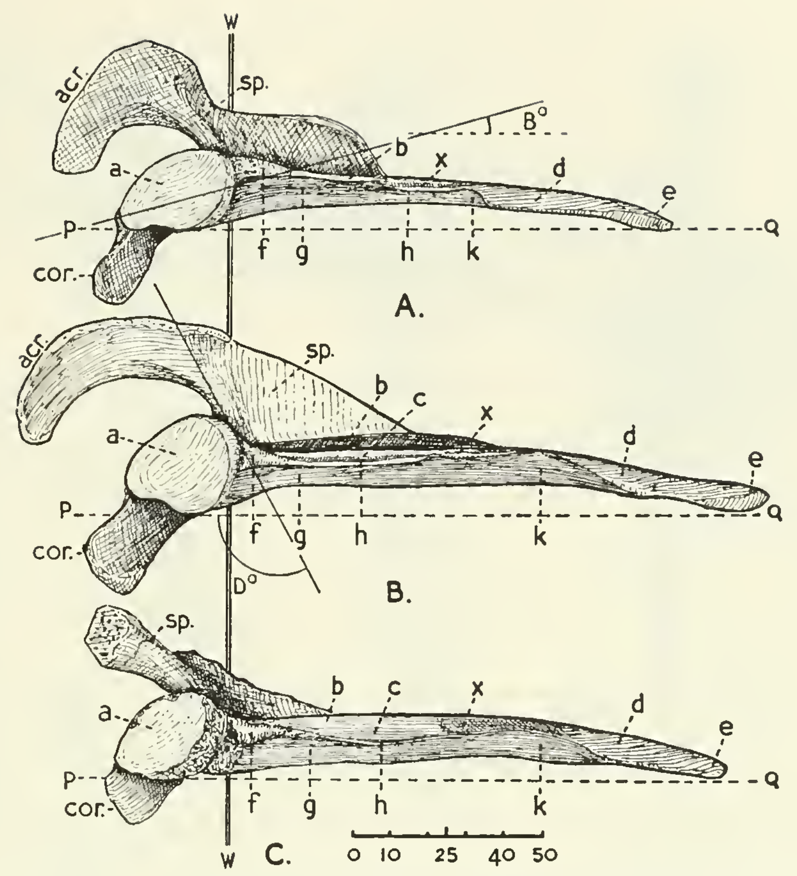


FIG. 91. THE SCAPULA, LEFT LATERAL ASPECT. A, Bushman; B, Sikh; C, Skhūl V. The infra-spinous (horizontal) plane (*P–Q*) is described in the text (p. 133). The vertical double line (*W–W*) represents the transverse plane (Figs. 88, 90). *a*, glenoid cavity; *b*, dorsal bar of the axillary border; *c*, marginal sulcus; *d*, dorsal area for attachment of teres major; *e*, lower angle; *f*, attachment of long head of the triceps; *g*, ventral bar in subscapular area; *h*, marginal crest for attachment of intermuscular septum; *k*, dorsal extension of the subscapularis; *acr.*, acromion; *sp.*, spine; *cor.*, coracoid process; *x*, attachment of teres minor. *B*°, angle formed by the long axis of glenoid with the plane *P–Q*, see p. 134. For *D*° see p. 134.

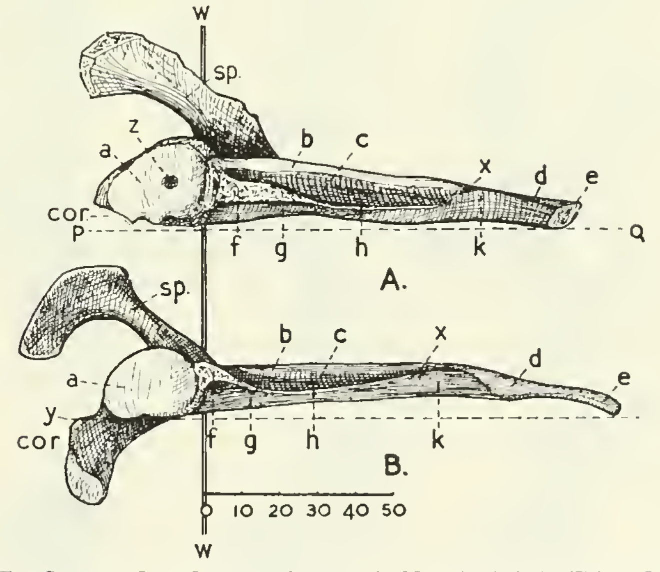


FIG. 92. THE SCAPULA, LEFT LATERAL ASPECT. A, Neanderthal; B, Tabūn I. Orientated and drawn as in Fig. 91. The letters have the same significance. Both scapulae show the complete development of the marginal (Boule's) sulcus (*c*). *z*, indicates the central pit in the glenoid fossa of the Neanderthal scapula. The attachment of the coracoid process is also indicated. *y*, the angular tubercle for the attachment of the coraco-acromial ligament.

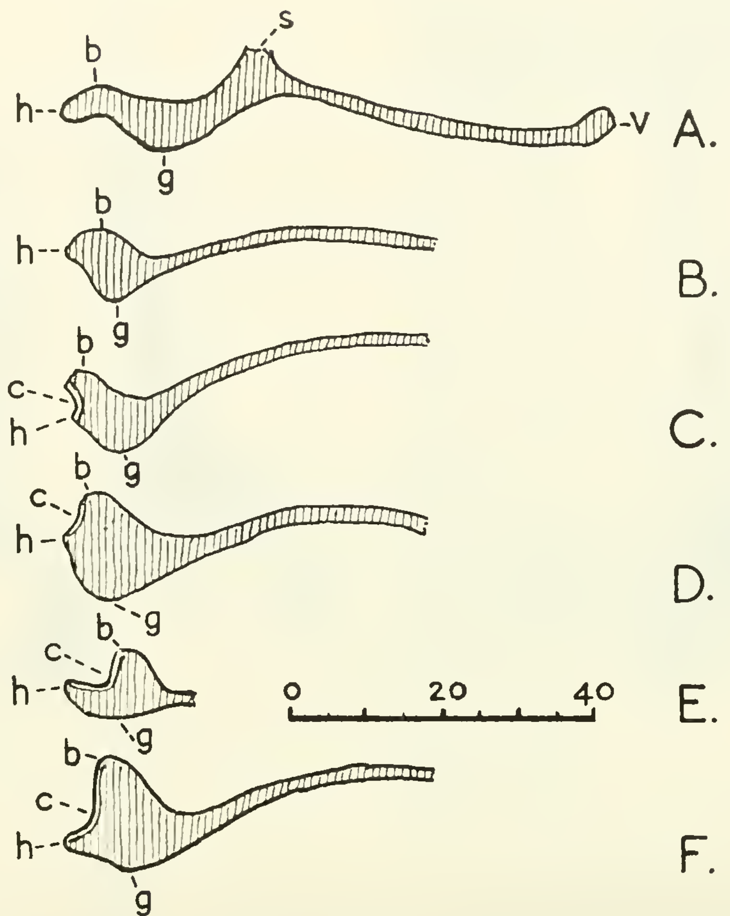


FIG. 93. TRANSVERSE SECTIONS OF THE AXILLARY BORDER OF THE SCAPULA MADE 30 MM. DISTAL TO THE GLENOID MARGIN. All sections are shown with the dorsal surface above and the ventral or subscapular surface below. A, Chimpanzee; B, Bushman; C, Sikh; D, Skhūl V; E, Tabūn I; F, Neanderthal (cast). *b*, dorsal bar; *g*, ventral bar; *h*, marginal crest; *c*, marginal fossa; *s*, spine; *v*, vertebral border.

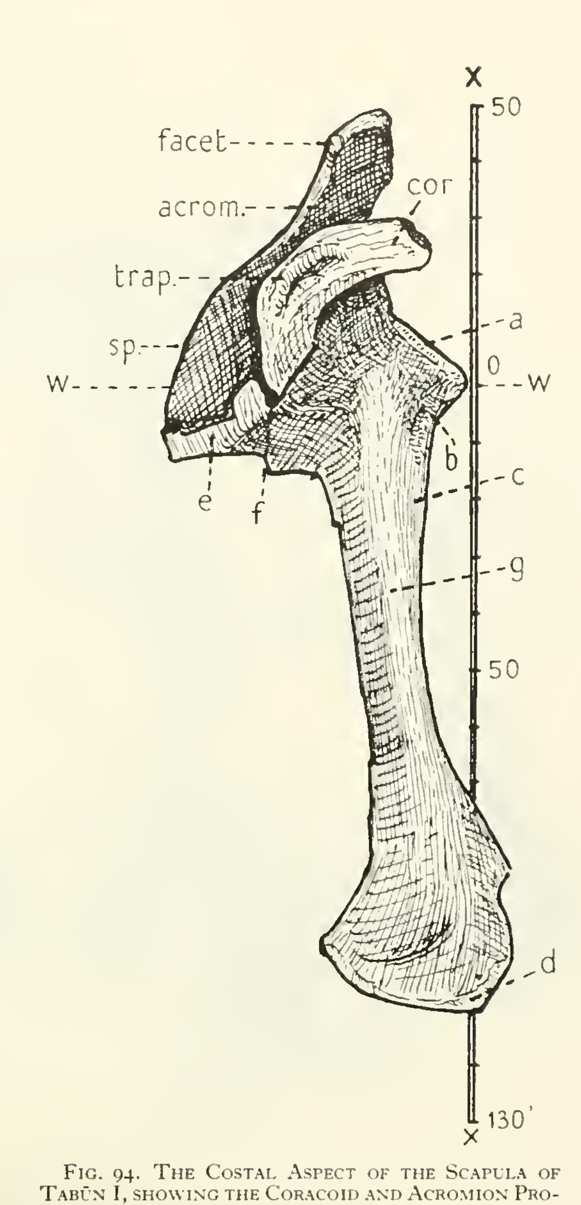


FIG. 94. THE COSTAL ASPECT OF THE SCAPULA OF TABŪN I, SHOWING THE CORACOID AND ACROMION PROCESSES. *a*, glenoid cavity; *b*, infra-glenoid tuberosity; *c*, marginal crest attached to the ventral bar (g); *d*, lower angle; *e*, fragment of the supra-spinous plate; *f*, crushed scapular notch; *cor.*, coracoid process; *sp.*, spine; *acrom.*, acromion, with facet for clavicle; *trap.*, ridge for the trapezoid ligament; *W–W*, horizontal plane.

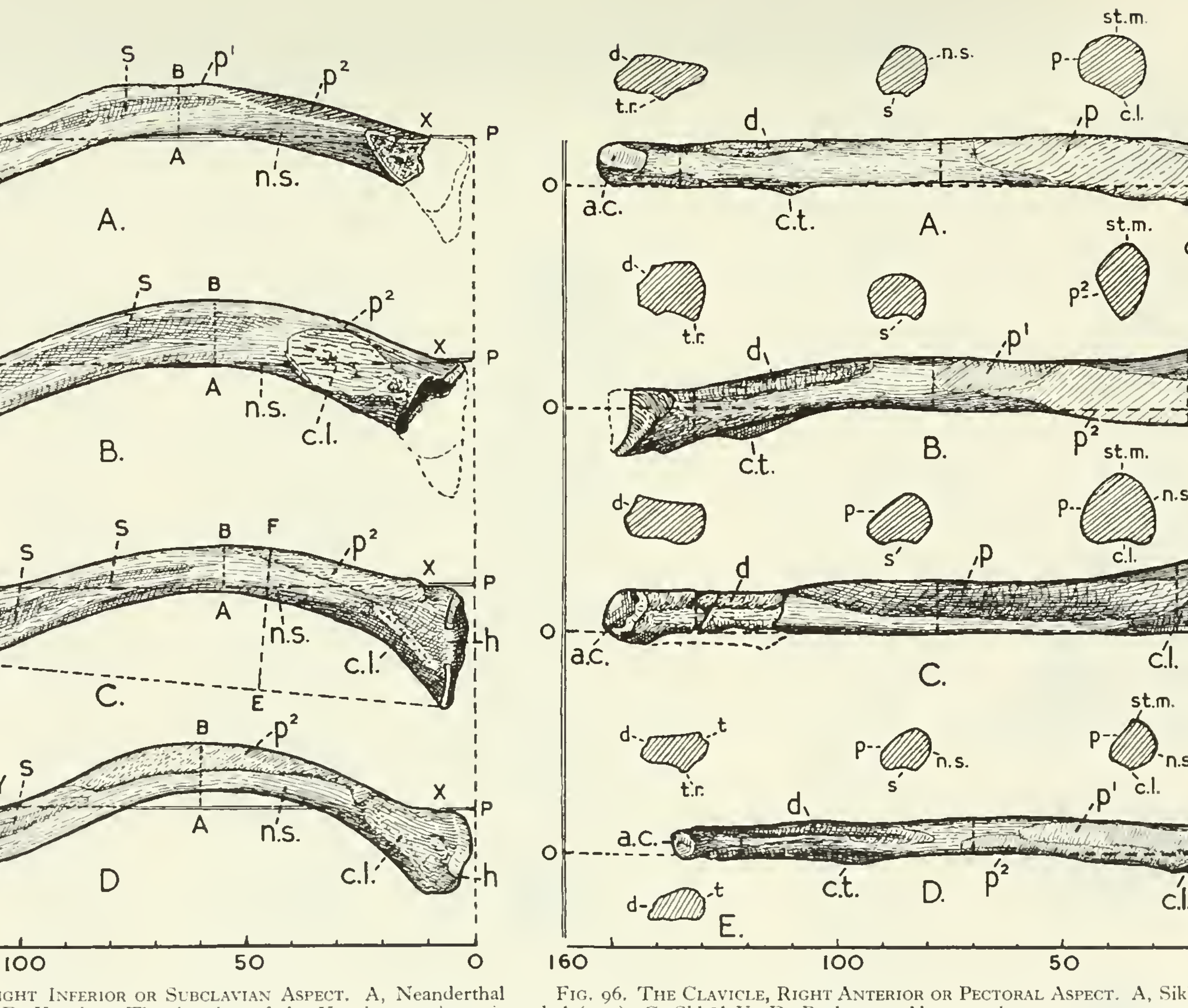


FIG. 95. THE CLAVICLE, RIGHT INFERIOR OR SUBCLAVIAN ASPECT. A, Neanderthal (cast); B, Skhūl V; C, Sikh; D, Krapina. The drawing of the Krapina specimen is based upon Kramberger's photograph. Orientated on the horizontal *P–P*, which forms the chord of the curvature (*X–Y*); the height (subtense) of the curvature is represented by *A–B*. The 'greater curvature' is measured by the line *E–F* (C), which ascends at right angles to a chord joining the two most posterior points of the bone. This measurement can seldom be made upon fossil clavicles owing to the absence of the sternal end. p^1, p^2, origin of parts of the pectoralis major muscle; *s*, groove for the insertion of the subclavius muscle; *c.l.*, area for the attachment of the costo-clavicular ligament; *n.s.*, posterior or nuchal surface; *c.t.*, tubercle for the attachment of the conoid ligament; *t.r.*, trapezoid ridge; *a.c.*, acromio-clavicular joint; *h*, 'hilum' of the sternal end.

FIG. 96. THE CLAVICLE, RIGHT ANTERIOR OR PECTORAL ASPECT. A, Sikh; B, Neanderthal (cast); C, Skhūl V; D, Bushman. Above each one are represented three vertical sections: (1) 15 mm. from the sternal end; (2) at the midpoint of the maximum length; (3) at the middle of the flat outer acromial section. E, a section made from an acromial fragment of Tabūn I. Each area of muscular origin is given a distinctive pattern. *O–O*, subclavian horizontal plane; *p*, pectoralis major origin; p^1, superficial or lateral part of the clavicular origin of the pectoralis major; p^2, inner or deep head, pect. major; *d*, deltoid origin; *t*, trapezoid insertion; *st.m.*, sterno-mastoid, site of origin; *ant.*, anterior or pectoral surface; *n.s.*, nuchal or posterior surface; *s*, insertion of the subclavius; *a.c.*, acromio-clavicular articulation; *t.r.*, trapezoid ridge; *c.t.*, conoid tubercle; *c.l.*, insertion of the costo-clavicular ligament; *h*, 'hilum' of the sternal articular surface (see text).

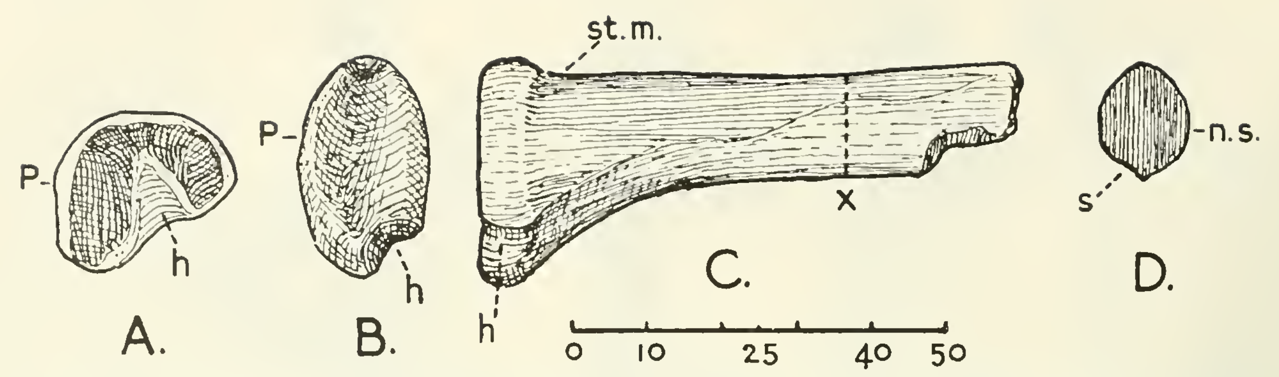


FIG. 97. A, The sternal articular surface of a large modern left clavicle (Sikh). It shows the obliquity of the long axis and a large hilum on its lower margin. B, the sternal articular surface of the left clavicle of Skhūl IV. C, the anterior aspect of the sternal end and adjacent part of the shaft of the left clavicle of Skhūl IV. D, Transverse section of the shaft made at *x* to show the acrocleidic form of the curved segment. *h*, hilum; *x*, point of transverse section; *p*, posterior surface of the clavicle; *s*, groove for the subclavius muscle; *st.m.*, sterno-mastoid attachment; *n.s.*, nuchal surface.

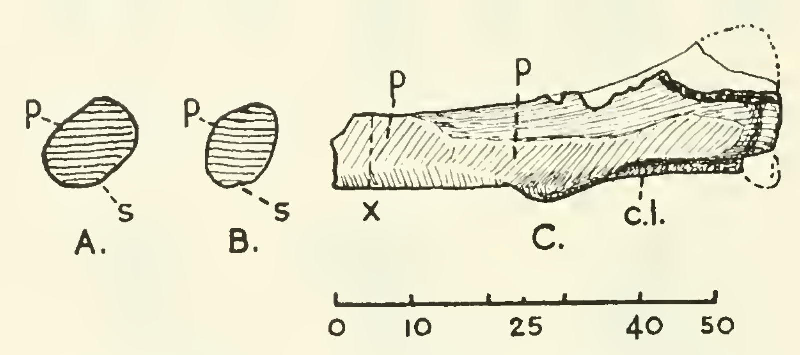


FIG. 98. A, Transverse section of the clavicle of Skhūl VI, made near its midpoint. B, Transverse section of the right clavicle of Tabūn I, made at *x*. C, The anterior aspect of the sternal end of the right clavicle of Tabūn I. The upper border, shown in outline, is transposed from the left clavicle.

CHAPTER X

THE HAND

CARPUS: METACARPUS: PHALANGES (Pl. XI; Figs. 99–109)

The following is a list of the specimens which were available for examination:

Tabūn I. Almost the whole carpus of the left hand, with the corresponding metacarpus and some phalanges (Fig. 99 A and Pl. XI B). The bones are deeply mineralized and preserve all details of structure.

Tabūn 3. A right os hamatum from the wrist of a woman. It has the same structural peculiarities as that of Tabūn 1, but is of a light orange yellow colour and not so appreciably mineralized.

Tabūn 4. A right pisiform, similar to the last specimen in state of preservation and in showing feminine characters. We attach importance to this specimen because in its characters it is of the Skhūl rather than the Tabūn type.

Tabūn 5. A terminal phalanx of the left thumb similar in colouring and mineralization to Tabūn 3 and 4.

Skhūl IV. Both right and left hands are well represented, as will be seen in Figs. 100 A, 101 A, the left more completely than the right. It is unnecessary to give a list of the bones and fragments of bones found, as they are depicted in the Figures just named and some of them in Plate XI. The details of structure are not so perfectly preserved as in the Tabūn specimens.

Skhūl V. Bones and fragments of bones were recovered from both hands. From the best preserved of these have been built up the composite hand shown in Fig. 101 B. The right hand is the more complete and is represented by the os multangulum majus (greater part), os multangulum minus (fragment), os capitatum (head defective), os hamatum, os triquetrum, the complete First metacarpal, the distal fourth-fifths of metacarpal II, metacarpal III (incomplete) and a few small fragments of phalanges. The left hand contributes metacarpals III and V (neither complete), the os multangulum majus, and the os triquetrum.

Skhūl VII. The hands of this woman are represented by several fragments, the principal ones being the base of metacarpal I (left), the bases of metacarpals II and III (left), and the shaft and proximal end of metacarpal II (right). These fragments assure us that the hand of this Skhūl woman was of about the same dimensions as that of the Tabūn woman.

Skhūl IX. Only one fragment of the hand was recovered. It is the base of the right fifth metacarpal. It has the deep brown colour and translucent lustre seen in so much of the skeleton of this individual. The fragment would seem to indicate that the hands of Skhūl IX were smaller than those of Numbers IV and V. As we have seen, Skhūl IX has many puzzling features.

Thus we have the bones of three hands, all of them more complete than in any burial of mid-Pleistocene date with perhaps one exception—that of La Ferrassie II. A photograph has been published of it by Boule (1923, p. 217) but no full account has yet appeared.

The records of the hands of Neanderthal Europeans published by Kramberger and by Boule we have utilized fully in our comparisons. In seeking to determine the relationships of the ancient Palestinians to modern man we have used, as before, bones drawn from the same three skeletons—those of a Sikh, a Bushman, and an Australian. More than before we have found it necessary to bring the carpus of the gorilla and chimpanzee into the circuit of our comparisons.

In making known in detail the characters of the Skhūl and Tabūn hands we are laying, we hope, a basis which may serve the needs of future discoverers. As we descend the upper extremity from the shoulder to the hand we find evolutionary changes and racial characterization to become more evident as we approach the fingers. In the hand, particularly in its carpal elements, we meet with many novel features which deserve description and illustration. That in the course of Man's evolution his hand should have undergone structural change need not surprise us, seeing the part it has played in re-making the conditions of life. We are proceeding, in our interpretation of structural change, under the belief that such are not produced by the effects of use but, having been brought about by factors not yet understood, use and wont will favour and select those changes which are most advantageous.

The Hand as a Whole.

When the upper extremity of modern Europeans is measured from the proximal end of the humerus to the tip of the middle digit, the hand, made up of carpus, metacarpus, and phalanges, is equal to about 25 per cent. of the total (25·5 per cent., Fick; cf. Martin, 1928, vol. ii, p. 1118). We are in a position to determine the proportion of the hand to the arm in the Tabūn woman. The total length of the arm was 679 mm.; the hand (*c.* 170 mm.)[1] forms 25 per cent. of the whole, approximately a normal proportion. When we compare the Tabūn measurements with those made on a Bushman's arm, the proportion of hand in the latter is very nearly the same, namely 24·5 per cent., the total length of the arm is almost the same (665 mm.), the length of the hand being 163 mm. In the left arm of Skhūl IV the total length is 807 mm. as against 724 mm., the mean for male Europeans. The length of the hand is 194 mm., against a mean of 185 mm. for Europeans. The proportion of hand to arm was 24·1 per cent. in Skhūl IV.

Skhūl V is the tallest man of our series but his hands are smaller than those of Skhūl IV. There are only two metacarpals of the hand of Skhūl V to guide us to the original dimensions, but these bones have the same measurements as the corresponding bones of the Sikh and we infer their hands had approximately the same length, namely 182 mm. In the Sikh, as in the Tabūn woman, Skhūl IV, and the Bushman the hand made up about 24–5 per cent. of the total length of the arm, whereas in Skhūl V the hand, if we accept 182 mm. as an estimate of its length, formed only 22·2 per cent. of the total. Skhūl V had relatively as well as absolutely long femora and humeri; the leg and fore-arm, on the other hand, were relatively short and so were the hands and feet. The Australian skeleton we used for comparison had an arm length of 768 mm., of which the hand, 175 mm. long, formed 22·8 per cent., approximately the same as in Skhūl V.

[1] The measurements of the hand given in this section were made on the drawings of the articulated specimens and are not based on the measurements made on the individual bones which are given in Tables XLI–LII (pp. 159–63).

When comparing the long bones of the Skhūl men with known prehistoric types we found their nearest parallels with the tall Cromagnon men described by Verneau. He gives certain measurements of the bones of the hand, but fortunately for us he also gives a photograph, natural size, of the right hand of the man from the Grottes des Enfants, so that we are able to take from it measurements which are directly comparable with those we have made of the hand of Skhūl IV. The hand is exactly the same length as in Skhūl IV, namely 194 mm. The length of the radius in both is also the same, but the Cromagnon humerus is longer by 23 mm., giving a total length of arm of 831 mm., against 807 mm. in Skhūl IV. In the Cromagnon the hand represents 23·3 per cent. of the total against 24·1 per cent. in Skhūl IV. It will be remembered that in Skhūl V the humerus was very long and that his hand represented only 22·2 per cent. of the total arm length.

Form of Hand.

We may classify hands into three types, the long and narrow (stenocheiric), the short and wide (eurycheiric—labouring hands), and the intermediate (mesocheiric). The clinging or anthropoid hand is pre-eminently stenocheiric. We determine the width of the palm by measuring the width of the proximal ends of metacarpals II–V, these being placed in the articulated position. We take the length of metacarpal III as representing the length of the palm, the measurement being made so as to exclude the basal spine. Hands in which the width measurement is 85 per cent. or more of the length we call eurycheiric. Those under 75 per cent. we call stenocheiric, and assign the intermediates (75–84 per cent.) to a mesocheiric category.

In the Tabūn woman the metacarpal base measures 43 mm., the metacarpal length 61 mm., the index being 70·5 (stenocheiric). The corresponding figures in the Bushman are 40 mm., 55 mm.; index 72·7. If we now take a Neanderthal woman of western Europe (La Ferrassie 2) and take measurements from the photograph which Boule reproduces half natural size, we obtain the following measurements: width 48 mm.; length 58·5 mm.; index 82. It is a relatively short and wide hand, falling in the upper range of the mesocheiric group. We have evidence here that the Tabūn Neanderthal type differs from the European Neanderthalians in having more slender bones and in being modern in type.

Turning now to the Skhūl hand as represented in the right hand of Skhūl IV we find the width to be about 54 mm., the length 69 mm., index 78·2—falling into the lower range of the mesocheiric group. We may compare these measurements with those taken from the hand of a labouring man of Europe, width 57 mm.; length 62 mm.; index 91·9—markedly eurycheiric. In the hand of a Sikh the corresponding figures are width 51·5 mm.; length 64 mm.; index 80·4—a representative modern mesocheiric hand. The dimensions on the hand of an Australian are width 48 mm.; length 62 mm.; index 77·4, very nearly the same index as in Skhūl IV although the absolute dimensions are less. Across the base the metacarpus of the Grottes des Enfants man measured 50 mm., the ratio of width to length of palm being 74·6 per cent. (stenocheiric)—relatively narrower than in Skhūl IV (78·2 per cent.). In the hand of a Tasmanian the width is 46 mm.; length 63 mm.; index 73—stenocheiric to about the same degree as in Tabūn I. Thus, the hand of the ancient Palestinians was formed as in the modern primitive races, but

in none of these moderns do we find hands of such large absolute dimensions as in the Skhūl men.

THE CARPUS

We do not propose to give the dimensions of the carpus as a whole; these can be obtained from our drawings. It suffices to say that the measurements are such as can be readily paralleled in the hands of modern peoples. We propose to proceed at once to a brief description of the individual members of the carpus, giving a table of dimensions for each bone. Nor can there be any doubt as to the bone which merits attention first. It is the os capitatum, the central member of the carpal group. In it we shall encounter a series of evolutionary changes of which we have been in ignorance hitherto for the good reason that the evidence has not been available.

Os capitatum.

The chief dimensions of this bone are given in Table XLI (p. 159). As regards the length it will be observed that the Tabūn bone is similar to that of the Bushman. The Krapina specimen exceeds that of even Skhūl IV, and of La Chapelle which was 24 mm. (Boule). This bone in the La Ferrassie woman was slightly shorter (20·5 mm.) and also slightly narrower than in the Tabūn woman, but on the evidence of Boule's photograph the two bones agree in structural features. The chief racial difference seems to lie in the degrees to which the head of the bone is flattened between the cup of the os naviculare on the radial side and the os hamatum on the ulnar aspect. This flattening is brought out in the measurements of the medio-lateral and dorso-ventral diameters of the head.

It is also apparent in the proportion of the width to the maximum dorso-volar (oblique) diameter. In the Tabūn specimen the flattening is extreme (66·6 per cent.), greater even than in either the chimpanzee or the gorilla. This is also a character of the Krapina bone. In Skhūl IV the proportions are those found in the same bone of modern races. In the Tabūn bone the width of the distal end is great as compared with the dorso-volar diameter. The width proportion is also high in Skhūl V, in the Australian and in the Krapina specimens.

In Fig. 102 we represent a series of evolutionary stages which have modified the lateral or radial aspect of this bone, the aspect in contact with the os multangulum minus —which for convenience we will write of under its old name of trapezoid. In Fig. 102 A, we see that this aspect of the bone in the chimpanzee is divided by a deep cleft or depression into a ventral limb (*b*) and a dorsal limb (*d*) which carries an articulation with the trapezoid (*c*). The articular impression for metacarpal II is divided by the cleft into dorsal and ventral moieties. In the Tabūn bone (B) we see the first stage of the filling up of this gap; it has been bridged and the impression for metacarpal II is now undivided. In the Bushman bone (C), the dorsal limb has become greatly reduced, the gap partly filled up and the ventral limb greatly extended. In that of the Sikh (D) we see a still further development in the unification of this area. The dorsal limb and the gap have almost disappeared and the ventral limb, carrying a new facet for the trapezoid, has obtained a great extension and has fused with the articular area of the head of the os capitatum. This new area for the trapezoid first makes its appearance in the Bushman specimen of our series. Unfortunately the Skhūl examples of this bone are incomplete;

in Fig. 102 E, we have combined that of the left hand of Skhūl IV with the right one of Skhūl V (stippled). We thus see that the articulations on the trapezoid aspect of the Skhūl os capitatum are of the Tabūn type, although there is already present a trace of the articulation for the trapezoid on the ventral limb. Thus, in the Tabūn bone we find a condition which has many chimpanzee features and in the Skhūl bone a step towards that condition shown in the os capitatum of the Bushman.

An equally remarkable series of changes in the hamato-volar aspect of the os capitatum is shown in Fig. 103. This aspect of the bone in the carpus of the gorilla is seen to be divided by a cleft or pit into dorsal and volar limbs. The dorsal limb carries the facets for the articulation with the os hamatum (*a*, *a'*); the volar limb serves as a basis for attachment of ligaments. In the chimpanzee the volar limb (Fig. 103 B) is seen to be more closely fused with the dorsal, leading to a narrowing of the cleft. In the Tabūn woman (C) the fusion has reached a further stage, leaving a deep circular pit under the head—the subcapitular pit. The process has gone still farther in the Bushman, while in the Sikh the cleft is obliterated, this being the normal condition in Europeans. Unfortunately both the Skhūl examples are broken along the line of the cleft, so that the Skhūl condition remains uncertain, but apparently the state was similar to that seen in the Bushman (D).

Our immediate interest is in the stage seen in the Tabūn specimen; it links the condition seen in the chimpanzee to that found in the Bushman. As to the significance of this series there is some doubt. We believe that it is correlated with a greater mobility in the thumb and index finger. These two digits are carried on the radial section of the carpus, made up of the navicular, the trapezium, and the trapezoid. The os capitatum is the main element of the ulnar section of the carpus. In the skilled movements of modern man not only is there an increase in the mobility at the transverse carpal joint, but also there is an increase at the vertical carpal joint which separates the radial from the ulnar section of the carpus.

Os hamatum.

Having examined the central bone of the carpus we shall now make a circuit of the carpus beginning with the os hamatum. In Table XLII (p. 159) we give its chief dimensions. It will be seen that Tabūn woman stands very close to Bushman, excepting those measurements which relate to the hamulus or hook process. The Skhūl specimens are imperfect, the most complete being that of Skhūl V (Fig. 104 E). Its dimensions are less than those of the Sikh. Unfortunately the hamulus is broken, but its body is smaller than that of the Sikh and we infer that its process was not longer. Indeed, as may be seen by comparing them (Fig. 104 D, E), there is a close agreement in the general characters of these two bones. It is otherwise in the case of the uncinate process of Tabūn I; it is very long, longer than in the chimpanzee (Fig. 104, upper series A, B). Otherwise the os hamatum of Tabūn I does not differ from that of a Bushman. We can find no description of the os hamatum from a Neanderthal skeleton.

As one of our chief objects is to determine the relationship of the Tabūn to the Skhūl people, the specimen labelled Tabūn 3 is of importance. It is of the right hand, of a woman, whereas Tabūn I is of the left hand. The colour and state of preservation are not the same, Tabūn 3 being the less mineralized and an orange yellow in colour.

The two bones are compared in Fig. 104. In both bones the process is relatively longer than in any modern specimen and that of Tabūn I is the stouter, although the process of Tabūn 3 is wider at its extremity. The bones present an identical structural pattern, the articulation in both for metacarpal V rising high on the base of the process. As has already been mentioned, we are of the opinion that in length of process the Skhūl people differed from the Tabūn folk and were modern in this respect.

Os triquetrum (*Cuneiform*).

In Table XLIII (p. 159) we give the chief dimensions of this bone. They call for no remark save the great absolute dimensions of the Skhūl triquetral or cuneiform bones. The greater length is due to a novel character, namely, the presence of an apical process (Fig. 105 D, *c*; Pl. XI D, *c*), which we have observed in no modern race, but it is present in the chimpanzee (Fig. 105 E), and there was a similar process, smaller in size, on the triquetral bones of Skhūl V. The other point in our table of measurements is the length of the facet for the pisiform in the chimpanzee. The correspondence of the Tabūn and the Bushman dimensions is also noteworthy. We have epitomized our observations on the cuneiform in Fig. 105, combining with it our study of the pisiform, for the two bones form a common functional unit in the ulnar section of the carpus. In the lower series of that figure we present the volar or pisiform aspect of the bone. The pisiform facet has a peculiar form in Skhūl IV (D); as in the chimpanzee, this facet is concave in its long diameter. In Tabūn I it has nearly the same form and size as in the Bushman, save that it approximates more to a triangular form. In the middle row of Fig. 105 we represent the proximal aspect of the bone; on this surface there is a corresponding pattern in all the specimens, (*a*) an articular or volar tuberosity in contact with the meniscus; (*b*) a dorsal basal tuberosity; (*c*) an apical tuberosity connected with the other two ridges or elevations. In Skhūl IV this apical tuberosity is exaggerated into a process or cauda, as in the chimpanzee. It will be noted that the markings of the Tabūn and Skhūl bones differ.

Os pisiforme.

From our table of measurements (Table XLIV, p. 160) the inference might be drawn that the Tabūn and Bushman pisiforms were almost alike. Nothing could be farther from the truth; the Tabūn pisiform is quite peculiar, unlike any specimen known to us. Indeed, had it not been that we had its facet on the cuneiform we might have remained in doubt as to its nature. In Fig. 105 B, middle series A, it is presented in articulation with the cuneiform, both being viewed on their ulnar aspect (see also Pl. XI D, *b*). This surface is flattened and smooth, with a concavity descending from its free margin to its base. In the upper row (Fig. 105) its proximal end is seen, that to which the tendon of the flexor carpi ulnaris is inserted. This aspect is triangular in shape. Corresponding views of other pisiforms are given in the middle and upper rows of Fig. 105. We can detect an approach to triangular form in the proximal aspect of the pisiform of Skhūl IV (D), but the tuberous elevation on its medial aspect is as evident as in modern bones. The Skhūl pisiform is provided at its distal end with a process or tail, corresponding to the one on the distal end of the cuneiform, and the articular surface for the triquetrum is concavo-convex. The bones in the upper row have the same orientation, the articular

base being indicated by (*t*). We infer that the Skhūl pisiform indicates an advance upon the Tabūn type, an advance towards the pisiform of modern races.

A pisiform was found in the Tabūn cave which we shall speak of as Tabūn 4. We have finally come to the conclusion that it belongs to the right hand and may very well be from that of the woman to whom we attribute the os hamatum, Tabūn 3. We have compared Tabūn 4 with the pisiform Tabūn I in Fig. 106. Their lateral (outer) aspects are compared in (A) and their proximal ends in (B). The proximal aspect of Tabūn I is concave. In Tabūn 4 it is convex although not so much so as in the Skhūl or the modern pisiform. Indeed, the proximal view of the bone (Fig. 106 B) is very like that of the Skhūl pisiform. On its lateral aspect (Fig. 106 A) we can see the beginning of the convexity. In type the Tabūn pisiform (No. 4) finds its nearest resemblance in the type of Skhūl IV, not Tabūn I.

Os lunatum.

Taking it all in all the os lunatum seems the most steadfast of the carpal bones. In Table XLV (p. 160) the measurements made on the chimpanzee bone give amounts which are not greatly different from those of the Sikh or of Skhūl IV. Those of Tabūn I do not differ much from measurements made on the Bushman bone.

At this point it will be well to glance at the character of the carpal bones in the chimpanzee (Fig. 107). We have mentioned the compression of the head of the os capitatum between the os naviculare (Figs. 99, 100, *a*) and the os hamatum. This is particularly marked in the chimpanzee. The compression also affects the os lunatum; this bone in the chimpanzee is relatively narrow and high. The Tabūn and Skhūl bones are not particularly narrow but they are relatively high. It is rather in the conformation of the surfaces than in actual dimensions that we see differences. In both the Tabūn and Skhūl lunate bones the radial articular surface is raised in a manner seen on the radial surface of the chimpanzee bone.

Os naviculare.

Although we made many measurements besides those given, they seemed to throw no light on the affinities of the individual of which they formed a part. The navicular is a more robust bone in the Tabūn woman than in the Bushman, and that of Skhūl IV is more robust than that of the Sikh. The chimpanzee navicular is more robust and larger than that of Skhūl IV as may be seen from Table XLVI (p. 160).

The chief differences brought out by a comparison of the ancient and modern navicular bones are shown in the drawing given in Fig. 108. There are four features in the os naviculare of the chimpanzee which merit attention (Fig. 108 A, also Fig. 107). These are: (1) a large non-articular area (*e*) divided by a ridge into dorsal and ventral parts; (2) the radial articular surface is directed more backwards than in the human navicular; (3) the distal articular surface appears to only a limited extent on the dorsal aspect; (4) the articular area for the trapezium is small, a correlation with the low development of the thumb. As may be seen in Fig. 108, the more dorsal of the non-articular areas has almost disappeared in the human navicular bones, and with this disappearance the distal articular surface with its contacts for trapezium and trapezoid has assumed a more dorsal position. This dorsal rotation is rather less in Tabūn I than in the modern bones.

Unfortunately the Skhūl navicular has suffered damage and is not a reliable witness. In it the dorsal rotation was apparently modern in extent. In both the Tabūn and the Skhūl specimens the proximal (radial) articular surface has the more dorsal direction of the chimpanzee.

Os multangulum minus (*Trapezoid*).

The appearance of this bone on the dorsum of the carpus is shown in Figs. 99, 100; in Fig. 107 for the Chimpanzee. The volar part only of the bone was present in the right hand of Skhūl IV (Fig. 101). The chief measurements are given in Table XLVII (p. 160). It will be noted that those for Tabūn I exceed those for the Bushman, the trapezoid in the former being a much stouter bone. On the other hand, the measurements for Skhūl IV are very similar to those for the Sikh.

We have already touched upon one remarkable feature of the trapezoid of Tabūn I, namely, that its dorsal articulation with the os capitatum is a mere rudiment, in this resembling the chimpanzee, in which this articulation is lacking. It is a striking fact that the Skhūl trapezoid is like the Tabūn specimen in this matter; there is but a trace of a dorsal articulation with the os capitatum (Fig. 102).

Although the trapezoid of the chimpanzee lacks a dorsal articulation with the os capitatum, it is well provided with articular attachments for navicular and trapezial bones. That for the navicular is triangular in shape, the base being on the dorsal margin of the bone. In the Tabūn trapezoid the navicular articulation has the same triangular form. The triangular shape is due to the fact that in the chimpanzee the bone is a pyramid, with the apex on the volar surface of the hand. In Tabūn I the pyramidal form is retained although the apex has become more obtuse than in the chimpanzee. In the Skhūl trapezoid the apical region has a polygonal appearance, is a narrow four-sided pillar. With the increase of the apical (volar) region of the trapezoid, the area of contact with the navicular becomes a narrow oblong as in the trapezoid of the Bushman or of the Sikh.

In the trapezoid we meet with evidence which favours not an identity, but a close relationship between the Skhūl and the Tabūn types although the Skhūl trapezoid represents a nearer approach to the prevailing modern form seen in the Sikh and in the Bushman.

Os multangulum majus (*Trapezium*).

This bone is missing in the Tabūn carpus, but we have the four surfaces with which it articulated, navicular, trapezoid, and first and second metacarpals. Apparently the articulation with the second metacarpal was not a close one as the facet on that bone is ill defined. As will be seen from Fig. 99 A, the trapezium from the hand of a Bushman filled the gap in the Tabūn carpus.

It will be observed in Table XLVIII (p. 160) that the two trapezia of Skhūl V were sufficiently complete to afford us the chief measurements (Fig. 101 B). They are smaller than modern examples from a Sikh and an Australian, the hands of Skhūl V being remarkably small for so tall a man. In Skhūl IV the articular surface for the first metacarpal was as large as in the Sikh and had the same conformation.

Pollex or Thumb.

The measurements of the specimens at our disposal are given in Table XLIX (p. 161). Illustrations of the pollex and the first metacarpal of Tabūn I are given in Figs. 99, 109 and Pl. XI B, C; of Skhūl IV, in Figs. 100, 101, and Plate XI, A; of Skhūl V in Figs. 101 and 109; of a Bushman in Figs. 99 and 109, and of an Australian in Fig. 101.

The length of the first metacarpal is given in Table XLIX (p. 161). That of the Tabūn woman is somewhat short. It represents only 67 per cent. of the length of the third metacarpal of her hand, whereas that of the Bushman is equal to 74·3 per cent. of its third metacarpal. The first metacarpal of Skhūl V is small for a man of great stature, yet it is in keeping with the rest of his hand, being about 71 per cent. of his middle metacarpal. In Skhūl IV, where this bone (metacarpal I) is absolutely long, it is equal to 70·8 per cent. of the middle bone; in a Tasmanian the pollicial metacarpal represents 73 per cent., in a Sikh 71 per cent. of the length of the middle element. The length of the Cromagnon metacarpal I, which apparently had the same robust shaft as in Skhūl IV, is 43 mm., 6 mm. shorter than in the latter, and representes 64·1 per cent. of the length of the middle metacarpal. The length of metacarpal I in the La Chapelle thumb was 44·5 mm., being only 62·6 per cent. of the length of the middle metacarpal. In the La Ferrassie man it was 65·2 per cent., and in the woman from the same site it was 66·6 per cent., almost the same as in the Tabūn woman. The La Ferrassie woman's first metacarpal is almost identical in length with that of the Tabūn woman. In its proportions, the thumb of the Tabūn woman was Neanderthaloid, while the Skhūl men were modern.

We give estimates of robusticity in Table XLIX (p. 161), based upon the proportion of the least circumference of the shaft to the total length. Skhūl IV has an extremely robust first metacarpal, his index being 85·4. In the Bushman it is 66·6, in Tabūn I 69·1, in Skhūl V 76·3. Nothing remarkable regarding the measurements of the proximal and distal ends of the bones is to be found. The distal end of the bone is relatively wide in the Tabūn specimen, representing 38·2 per cent. of the total length, whereas in the Bushman the proportion is only 31·8 per cent., in Skhūl V it is 38·7 per cent., and in Skhūl IV 35·4 per cent. A wide distal end is a Neanderthal character but it is not of diagnostic significance.

It is the anatomical configuration rather than the measurements which gives indication of the racial affinities of the Palestinians. In Fig. 109 we give drawings of the dorsal aspect of the first metacarpals of Tabūn I (A) and Skhūl V (C). There is a ruggedness of outline in these two bones which is not apparent in the modern bones with which we have compared them. The dorsal aspect of the Tabūn specimen is invaded by two muscular impressions (Fig. 109, *c*, *d*); the massiveness of the tubercles at each side of the distal end is also apparent.

Proximal phalanges of the Thumb.

The relative shortness of the Tabūn proximal phalanx, compared with the Bushman's, is again to be noted. Those of the Skhūl males agree in length with that found in modern peoples. The two specimens recorded by Kramberger are remarkably short (26 mm., 24 mm.). The Skhūl phalanges are very robust, more so than in modern native races (Table L, p. 161). It is also noticeable when we compare the Tabūn specimens with those of Krapina that the latter are flatter and apparently their distal ends are narrower.

We suspect that this difference is due to Kramberger measuring only the articular extremities, whereas we, following the technique of Martin, have included the tubercles as well.

Distal phalanges of the Thumb.

Unfortunately that of Tabūn I is missing, but in order that an estimate might be made of the absolute length of the thumb and the proportion this bore to the whole middle digit, we have used the isolated terminal phalanx Tabūn 5 (Fig. 99 A, *x*). The colour and mineralization are identical with the specimens Tabūn 3 and 4. Its shape and characters agree with what one might expect to be the condition in the Tabūn I pollex. The length, 18·7 mm., is a little less than the same bone in the Bushman hand (19 mm.). The base measures 12×7 mm. and the expanded sub-ungual extremity had a width of 8 mm. and a thickness of 4 mm. The same measurements in the Bushman terminal phalanx are 12·4×7·5 mm. for the base and 6·3×2·7 mm. for the terminal piece.

The length of the thumb in Tabūn I represented by the sum of the three pollicial segments is 85·2 mm. The same measurement in the Bushman is 90 mm. In the La Ferrassie woman it is approximately 88 mm. Unfortunately we have to be content with an estimate of the length of the Tabūn middle digit; it was approximately 137 mm. (Fig. 99 A). The thumb thus represents less than 63 per cent. of the middle digit whereas in the Bushman it is 66·6 per cent. of that length.

The terminal phalanx of the left thumb of Skhūl IV was recovered (Fig. 100 A). It is as massive as the bone commonly found in the thumb of a European labourer. Its length is 23 mm.; width of base, 15·5 mm.; dorso-volar diameter of base, 9·5 mm.; width of terminal piece, 12·7 mm. The total length of the thumb in Skhūl IV is 104·8 mm.; the length of the middle digit 159 mm.; the proportionate length of the thumb, 64·7 per cent. The corresponding lengths given by Fick for modern European males are: 92·7 mm. (thumb), 149·6 mm. (middle digit); giving a thumb proportion of 62 per cent. In an Australian measured by us the thumb measured 89 mm., the middle digit 144 mm., the proportion being 61·8 per cent. Thus, in all the Palestinian hands the thumb is quite equal to the modern development, the digits of Skhūl IV being particularly long. Unfortunately we have no Neanderthal standard, the only specimen being a photograph of the La Ferrassie woman. In this instance we estimate the thumb element to have had a length of *c.* 88 mm., the middle digit *c.* 134 mm., thumb proportion 65·6 per cent. In relative development of thumb to middle digit there seems to be no marked difference between mid-Pleistocene man and modern. In the Cromagnon example already cited the total length of the thumb was 102 mm., against 104·8 mm. in Skhūl IV. The ratio of the total length of thumb to that of the middle digit (160 mm.) is 63·7 per cent. In all these points there is a close resemblance of the Cromagnon to the Skhūl type.

Metacarpals II, III, IV, V.

In Figs. 99 A, 100 A, 101, we have given drawings of the dorsal aspect of the metacarpals of the Tabūn and the Skhūl hands, while in Figs. 99 B, 100 B, are shown the hands of two modern natives for comparison. Although we have derived but little information to guide us in discriminating one race from another from our examination of the metacarpals, yet since so little is known of those of fossil man, it seems incumbent on us to

record here the results of our measurements for the guidance of future observers. We give therefore the chief measurements (Tables LI, A–D, pp. 161–2) relating to these bones, adding a brief summary of the inferences we have drawn from the tables.

We may add a note here on the diameters taken at the mid-point of the shaft. These show extreme variability. The Tabūn third metacarpal measures 6·4 mm. in its medio-lateral diameter, 7·8 mm. in its dorso-volar. The corresponding measurements in the Bushman are 7·1, 7·8 mm.; in Skhūl IV 8·5, 10 mm.; in the Sikh 8, 10 mm. The shaft of metacarpal II of Skhūl VII is almost round (7 × 7·5 mm.); this bone in Skhūl IV measures at its mid-point 8·3 × 11·3 mm. When we sum up the inferences to be drawn from the measurements, they are, in the main, negative. The figures for Tabūn I have close parallels to those of a Bushman, and those for the Skhūl bones to the corresponding ones for the Sikh's metacarpals. There is a similar range in robusticity, although the Tabūn metacarpals have bases which are more massive relative to the shaft than is the case with modern bones, a Neanderthal feature. The metacarpal length index in Tables LI, A–D (pp. 161–2) gives the proportionate lengths of each metacarpal to the third, this being used as a standard. The relative lengths of the series brings out no point of racial difference. In the Tabūn series the middle metacarpal is stronger than the second; in the Skhūl hands, as in most moderns, the second is the stronger. In the manner of their articulation to the carpus and in the articulation of one base with another we have detected no point in which the Palestinians are peculiar. On the other hand, the impressions made on the dorsal aspect of the metacarpals by the dorsal interosseous muscles are particularly well marked in the Tabūn hand (Fig. 99 A).

Proximal phalanges of Digits II–V.

As will be seen by comparing Figs. 99 A and B, the phalanges of the index and middle fingers of the Tabūn woman are more robust and massive than those of the Bushman. Only four phalanges were found of Tabūn I; a proximal of the index (nearly complete), the proximal of the middle digit (basal half of the bone), two complete middle phalanges which we think are assignable to the second and third digits, and a terminal phalanx which is probably from the third digit.

The only series of Neanderthal phalanges which have been discovered, measured, and published are those found at Krapina. The five proximal phalanges described vary in length from 28 to 41 mm. The phalanges available from the Skhūl IV hands are depicted in Figs. 100 A, 101 A. There were only fragments from the fingers of Skhūl V.

It will be seen from the data given in Table LII, A (p. 163) that in length and in the measurements of the proximal end the Tabūn proximal phalanges agree closely with the Krapina series. In shaft diameters the Tabūn proximal phalanges are wider and larger than the Krapina specimens. The Skhūl proximal phalanges are much longer than any found at Krapina, and in their proportions and structural features they resemble the modern type, not the Neanderthal.

Middle phalanges of Digits II–V.

The Skhūl middle phalanges seem to the eye to be particularly robust, but this is not brought out by the measurements (Table LII, B, p. 163). The Tabūn and Krapina

middle phalanges are alike in size of base and shaft, but the distal ends of the Krapina specimens seem to be the wider.

Terminal phalanges.

Only one complete example was found, that which belongs to the middle digit of the right hand of Skhūl IV. Kramberger was more fortunate at Krapina; he gives measurements of five specimens which varied in length from 19 to 21 mm. Our specimen, which is quite complete, is only 16·6 mm. in length; that of the Sikh is 17·1; of an Australian male 19·5 mm. We shall take the second in the Kramberger series for comparison, its length being 20 mm., its base 11 mm. wide and 6·3 mm. thick. On our specimen the measurements of the base are 11·5 × 6·6 mm.; in the Sikh phalanx, 11·9 × 7 mm.; in an Australian, 11·3 × 6·7 mm. Plainly the flattening of the base is greater in the Krapina specimen. The terminal sub-ungual expansion was well developed in the Krapina specimens, varying from 7 to 10·9 mm. in width, No. 2 being 9 mm. wide. In our specimen the terminal expansion is 9 mm. wide and 3·5 mm. thick, very near to the Krapina specimen which we have used for comparison. In modern native races the expansion is narrower. In the Sikh used here it is 7·5 mm., in an Australian 8 mm., but in the hands of labouring Europeans it may be 10 mm. wide or more.

The characteristic flatness of the terminal part of the phalanx also is evident in the middle part of the shaft. The Krapina No. 2 specimen measures 6·8 × 3·8 mm. at the mid-point of the shaft. Our specimen (Skhūl IV) measures 6·5 × 4·5 mm., the Sikh is 5·8 × 4 mm., and an Australian bone is 6·1 × 4·5 mm. at the same point. The flatness of the Krapina specimen is evident. The Skhūl bone is more akin to the modern than to the Krapina type.

There is an incomplete terminal phalanx of Tabūn I. The terminal part is lacking, but the original length must have been about 19 mm. The base measures 9·5 × 6·5 mm. and the shaft 6·3 × 3·5 mm. These figures are greater than for the corresponding Bushman phalanx (length: 16 mm.; base: 9 × 5·5 mm.; shaft: 4·2 × 3 mm.), but they agree well with the smallest of the Krapina specimens (length: 19·1 mm.; base: 9·5 × 5·9 mm.; shaft: 4·3 × 3·1 mm.). The Tabūn specimen is a longer and more slender bone than the Skhūl example.

Summary of the Hand.

We are impressed by the robustness of the hands of the Skhūl men, hands which betoken great physical strength, especially of the thumb. Our survey of the hands as a whole gives little to enlighten us as to the kinship of our people. Certainly the Tabūn hand is long when the absolute length of the upper extremity is taken into consideration, but such a proportion occurs among modern people. The anatomical evidence of the carpus and of the other bones of the hand lead us to distinguish between the Tabūn and the Skhūl type of hand, but intermediate features give us an assurance that the Skhūl and the Tabūn types are closely related. They are members of a series which link modern (Neanthropic) to Neanderthal (Palaeoanthropic) types, the Tabūn type being placed towards the Neanderthal end of the series, the Skhūl form towards the modern end.

We have felt it our duty to give full records, verbal, graphic, and photographic, of the bones of the hand, there having been so few specimens available until now. In our

examination of the carpus we have come across certain structural changes, especially involving the os capitatum. Yet, when we have told all, we are more than ever impressed by the fact that the human hand had attained all its essential characters by mid-Pleistocene times. We have, above all, as in the other parts of the limbs, been struck by the recurring similarities between the Skhūl and the Cromagnon form of hand.

Table XLI. OS CAPITATUM

	Tabūn I	*Bushman*	*Skhūl IV*	*Sikh*	*Australian*	*Skhūl V*	*Chimpanzee*	*Gorilla*	*Krapina**
	L	L	L	L	L	R	L	L	R
Maximum length M 1	21·0	21·0	(26·0)	24·5	25·0	(23·5)	21·5	28·0	27·5
Diameters of the head:									
least medio-lateral†	10·0	10·4	13·3	11·7	12·0	..	10·0	14·2	12·6
major dorso-volar (oblique)†	15·0	13·0	15·5	14·3	14·2	..	13·8	20·5	18·0
Medio-lateral-dorso-volar head index	66·6	82·3	85·8	81·8	84·5	..	72·5	69·2	70·0
Diameters of distal end:									
medio-lateral diam.‡	15·0	10·2	18·0	14·2	16·0	(14·3)	13·0	19·5	17·6
dorso-volar diam. of distal end	18·0	14·3	..	19·3	18·0	(18·0)	17·5	27·4	22·0
Medio-lateral-dorso-volar index of distal end	83·3	71·3	..	73·5	88·8	79·4	74·2	71·1	80·0

* The measurements of the Krapina bone are taken from Kramberger (1906, p. 230).
† After Kramberger.
‡ Made at right angles to the long axis of the distal face.

Table XLII. OS HAMATUM

	Tabūn I	*Tabūn 3*	*Bushman*	*Skhūl IV*	*Skhūl V*	*Sikh*	*Australian*	*Chimpanzee*
	L	R	L	R	R	R	L	L
Maximum length M 1	15·0	16·7	14·8	(20·0)	17·7	18·5	19·0	21·0
Distal end:								
width M 8	12·2	11·0	12·4	..	13·2	15·5	15·0	15·5
dorso-volar diam. M 9	11·4	11·3	11·0	..	(14·0)	14·2	13·5	11·2
Total height M 3	21·0	19·8	18·0	..	(21·0)	22·6	21·0	20·0
Length of hamulus*	9·6	8·5	6·3	..	..	8·4	7·5	9·0
Width of hamulus	9·0	9·6	7·0	..	..	10·0	8·5	12·0
Thickness of hamulus (medio-lateral diam.)	5·5	6·2	4·0	..	..	5·0	5·0	7·0

* The total height less the dorso-volar diameter of os hamatum.

Table XLIII. OS TRIQUETRUM

	Tabūn I	*Bushman*	*Skhūl IV*		*Skhūl V*		*Sikh*	*Australian*	*Chimpanzee*
	L	L	L	R	L	R	L	L	L
Greatest length M 1	14·2	14·6	16·7	17·2	(13·7)	15·5	16·0	18·0	19·0
Diameters of base:									
medio-lateral M 2	10·0	10·3	12·4	13·5	(12·0)	11·0	11·0	12·0	12·0
dorso-volar M 3	8·0	8·4	9·8	10·3	(9·5)	9·7	12·0	12·0	13·6
Facet for pisiform:									
length M 9	8·6	7·5	11·4	10·5	..	10·0	11·4	9·2	14·0
width M 8	6·4	4·5	8·2	9·0	..	8·3	7·0	7·8	6·3

Table XLIV. OS PISIFORME

	Tabūn I	*Tabūn 4*	*Bushman*	*Skhūl IV*	*Sikh*
	L	R	L	L	L
Maximum length M 1	11·0	13·0	11·2	16·0	15·0
Maximum width M 2	6·3	8·5	6·3	9·0	9·0
Height M 3	6·0	8·3	10·6	11·9	9·5
Length artic. base M 5	8·5	8·0	8·7	13·0	10·0
Width artic. base M 4	5·0	6·5	6·0	8·5	8·8

Table XLV. OS LUNATUM

	Tabūn I	*Bushman*	*Skhūl IV*	*Sikh*	*Chimpanzee*
	L	L	L	L	L
Maximum length M 1	13·0	11·0	16·1	14·0	15·8
Maximum width (radio-ulnar diam.) M 2	13·4	13·0	13·6	13·2	13·0
Maximum dorso-volar diam. M 3	14·0	14·5	18·0	17·6	17·0
Dorso-volar diam. of proximal (radial) surface	12·8	14·7	18·0	17·0	18·0

Table XLVI. OS NAVICULARE

	Tabūn I	*Bushman*	*Skhūl IV*	*Sikh*	*Chimpanzee*
	L	L	L	L	L
Maximum length M 1	(23·0)	21·4	(26·0)	24·0	26·0
Maximum width M 2	(14·0)	11·6	(16·0)	14·0	18·0
Maximum dorso-volar diam. M 3	11·5	12·0	(12·0)	13·0	15·0

Table XLVII. OS MULTANGULUM MINUS

	Tabūn I	*Bushman*	*Skhūl IV*	*Sikh*	*Chimpanzee*
	L	L	L	L	L
Maximum length M 1	14·5	13·0	16·8	16·0	16·6
Maximum width M 2	11·0	9·0	12·0	10·0	11·5
Maximum height (dorso-volar) M 3	16·0	14·3	19·3	20·0	12·5
Facet for metacarpal II:					
dorso-volar diam.	13·5	13·7	17·0	15·0	15·0
radio-ulnar diam.	10·5	9·0	10·0	10·0	8·0

Table XLVIII. OS MULTANGULUM MAJUS

	Skhūl IV		*Skhūl V*		*Sikh*	*Australian*
	R	L	R	L	R	L
Length M 1	..	..	11·6	13·5	14·0	15·5
Width M 2	21·0	..	(19·6)	20·0	22·5	23·5
Dorso-volar diam. excluding tuberos.	15·0	13·2	13·0	12·0	14·0	12·5
Articular surface for metacarpal I:						
width	17·5	17·8	16·2	15·5	17·2	15·0
dorso-volar diam.	15·2	14·0	11·3	..	10·5	12·0
Depth transv. curve of metacarpal joint	2·5	1·6	1·6	1·6	1·8	1·6

Table XLIX. FIRST METACARPAL

	Tabūn I	Bush-man	Skhūl IV		Skhūl V	Skhūl VII	Sikh	Tas-manian
	L	L	R	L	R	L	L	R
Maximum length . . .	40·5	42·0	(48·0)	49·0	46·5	..	46·4	45·0
Least circumference . . .	28·0	28·0	41·0	..	35·5	(32·0)	37·0	36·0
Index robusticity . . .	69·1	66·6	85·4	..	76·3	..	80·0	80·0
Diameters of proximal end:								
transverse	14·0	13·5	17·5	..	17·0	(13·0)	15·0	17·0
dorso-volar	(15·0)	13·6	(18·0)	(17·0)	16·0	14·0	16·0	15·5
Diameters of distal end:								
transverse	15·5	13·4	17·0	..	18·0	..	17·0	16·4
dorso-ventral	12·6	12·4	13·0	14·0	13·5	..	14·0	13·7
Diameters near mid-point of shaft:								
transverse	9·0	10·0	15·0	(14·5)	13·0	..	14·0	13·0
dorso-ventral	7·8	8·3	11·2	..	10·3	..	9·0	9·2

Table L. THE POLLEX, PROXIMAL PHALANX

	Tabūn I	Bushman	Skhūl IV		Sikh	Tasmanian	Krapina*
	L	L	L	R	L		
Maximum length M 3 .	26·0	29·0	35·4	35·0	30·8	34·0	26·0
Least circum. shaft .	23·0	23·0	30·0	30·0	26·5	27·5	..
Index of robusticity .	88·4	79·3	84·7	85·7	86·0	80·8	..
Proximal end:							
width	15·0	14·5	(19·8)	18·0	16·5	17·0	17·3
dorso-volar diam. .	10·5	10·0	(13·0)	13·5	12·4	12·0	9·6
Distal end:							
width	12·0	11·0	13·0	..	13·0	12·4	10·3
dorso-volar diam. .	7·5	7·0	9·5	(9·0)	8·3	8·6	5·6

* After Kramberger (1906, p. 232).

Table LI A. METACARPAL II

	Tabūn I	Bushman	Skhūl IV		Skhūl V	Skhūl VII	Sikh
	L	L	R	L	R	R	L
Maximum length	(63·0)	60·4	74·0	..	(67·0)	(65·0)	68·0
Least circum. of shaft . .	24·0	23·2	31·0	(32·0)	28·0	(24·0)	29·0
Index of robusticity	38·1	38·4	41·8	..	41·7	37·0	42·6
Diameters of proximal end:							
transverse	15·4	14·4	(20·0)	19·1	..	(13·0)*	18·2
dorso-volar	15·5	15·1	..	18·4	..	16·0	16·4
Diameters of distal end:							
transverse (excluding lat. tubs.)	..	13·0	17·0	..	14·1	12·3	15·8
dorso-volar	..	12·0	..	..	(12·0)	12·0	13·5
Metacarpal length index† . .	103·2	107·0	106·9	..	103·0	..	106·7

* Base of the left bone.

† Proportion of total metacarpal length to that of metacarpal III, its length being taken as 100.

Table LI B. METACARPAL III

	Tabūn I	*Bush-man*	*Skhūl IV*		*Skhūl V*	*Skhūl VII*	*Sikh*	*Tas-manian*
	L	L	L	R	L	L	L	R
Length (excluding spine) . .	61·0	56·4	69·2	..	(65·0)	..	63·7	61·0
Least circum. of shaft . .	23·0	22·0	30·0	..	29·0	..	30·0	30·0
Index of robusticity . . .	38·3	39·0	43·3	..	..	..	47·1	49·1
Diameters of proximal end:								
transverse	13·3	11·0	13·7	14·5	..	(12·0)	14·2	14·3
dorso-volar	15·0	12·3	(17·0)	18·0	..	(14·0)	16·0	15·0
Diameters of distal end:								
transverse (excluding lat. tubs.)	12·2	11·6	13·0	12·5	..	..	15·0	15·5
dorso-volar	13·0	12·2	14·0	13·7	..	..	13·5	13·0

Table LI C. METACARPAL IV

	Tabūn I	*Bushman*	*Skhūl IV*		*Sikh*
	L	L	R	L	L
Maximum length	(50·0)	50·3	(59·3)	59·4	58·5
Least circum. shaft	19·0	19·0	..	(26·0)	23·5
Index of robusticity	37·3	37·7	..	43·7	40·1
Diameters of proximal end:					
transverse	10·6	9·1	11·5	12·0	11·7
dorso-volar	10·3	10·0	14·0	..	12·4
Diameters of distal end:					
transverse (excluding lat. tubs.)	..	11·0	(13·4)	..	12·0
dorso-volar	..	11·0	(13·2)	(13·0)	12·3
Metacarpal length index	81·9	89·2	91·3	85·8	91·8

Table LI D. METACARPAL V

	Tabūn I	*Bush-man*	*Skhūl IV*		*Skhūl V*	*Skhūl IX*	*Sikh*
	L	L	L	R	R	R	L
Maximum length	46·4	46·0	(58·0)	..	..	..	53·3
Least circum. shaft	19·0	19·0	..	..	(26·0)	(23·0)	25·0
Index of robusticity	40·9	41·3	..	..	..	..	46·9
Diameters of proximal end:							
transverse	11·8	9·6	(13·5)	13·4	..	12·0	13·8
dorso-volar	(10·4)	8·0	(12·3)	10·3	..	10·0	11·5
Diameters of distal end:							
transverse (excluding lat. tubs.) . .	11·2	9·8	..	..	..	..	11·7
dorso-volar	10·6	9·9	..	..	..	..	11·0
Metacarpal length index	76·0	81·5	83·8	..	..	..	83·6

Table LII A. PROXIMAL PHALANGES

	Krapina		*Tabūn I*		*Skhūl IV*		*Sikh*	*Skhūl IV*	
	1	3	II	III	III	III	III	IV	V
			L	L	R	L	L	R & L	L
Length	41·1	37·3	(37·5)	(39·0)	49·2	48·5	44·8	(46·0)	38·0
Proximal end:									
width	15·0	15·0	13·2	15·0	17·8	15·0	16·6	15·2	15·0
dorso-volar diam.	12·1	11·0	11·0	12·0	13·8	..	13·0	12·0	11·0
Mid-point of shaft:									
width	8·2	8·2	9·2	10·0	11·0	10·8	9·6	9·2	9·6
dorso-volar diam.	6·3	5·4	5·8	6·6	7·8	7·2	7·6	7·5	6·0
Distal end:									
width	11·0	10·0	..	..	14·0	14·0	12·3	..	11·0
dorso-volar diam.	6·2	6·0	..	..	9·0	9·0	8·3	..	7·5
Circum. at mid-point of shaft	..	..	26·0	(28·0)	31·0	30·0	30·0	(27·0)	26·0
Index of robusticity	..	..	70·0	71·8	70·0	61·8	67·0	58·7	68·4

Table LII B. MIDDLE PHALANGES

	Krapina		*Tabūn I*		*Skhūl IV*			*Sikh*	*Skhūl IV*	
	1	4	II	III	II	III	IV	IV	V	V
			L	L	R & L	L	R	L	R	L
Length	28·5	23·0	24·4	25·0	(29·0)	30·0	26·0	24·0	25·0	(25·8)
Circum. at mid-point of shaft	..	..	21·0	23·0	(23·0)	27·0	24·0	23·0	23·0	..
Index of robusticity	..	..	86·0	92·0	79·3	90·0	92·3	95·8	92·0	..
Proximal end:										
width	14·6	14·3	12·5	13·3	15·0	15·0	13·7	13·5	12·0	12·0
dorso-volar diam.	10·3	9·6	8·5	9·5	10·5	10·5	9·7	10·0	(8·0)	9·0
Mid-point of shaft:										
width	9·5	8·6	9·0	8·5	9·5	10·2	9·6	8·2	8·2	7·5
dorso-volar diam.	5·2	5·0	5·0	5·2	6·0	6·2	6·5	6·0	6·0	4·8
Distal end:										
width	11·6	11·4	9·6	10·6	..	11·8	10·0	10·3	11·0	10·0
dorso-volar diam.	5·2	5·0	5·0	5·8	..	6·5	6·0	6·8	6·0	5·0



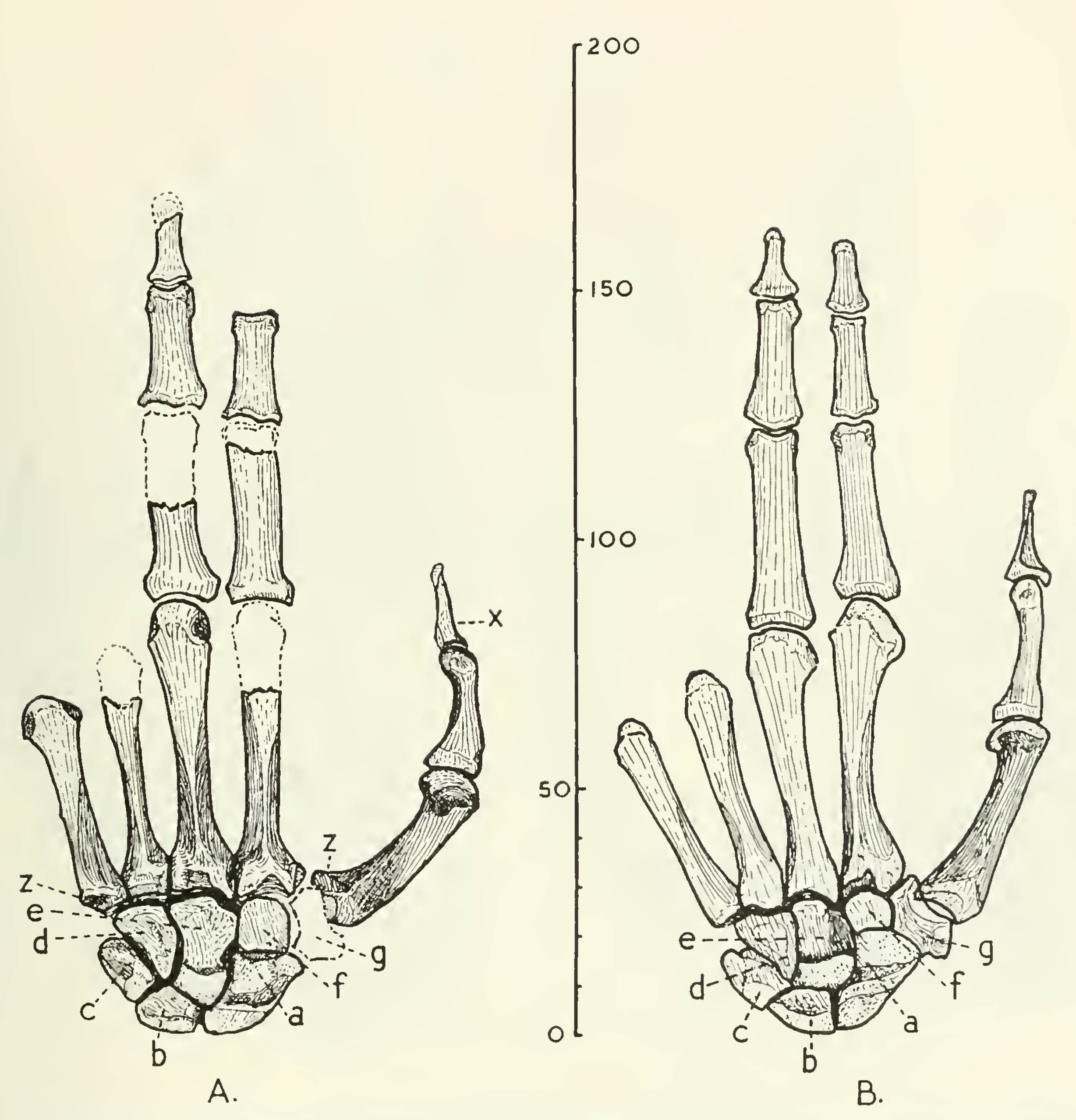


Fig. 99. Dorsal Aspect of the Left Hand. A, Tabūn I (missing parts are shown by a broken line; the outline of the os multangulum majus is taken from the Bushman's carpus); B, Bushman. *a*, os naviculare; *b*, os lunatum; *c*, os triquetrum; *d*, os hamatum; *e*, os capitatum; *f*, os multangulum minus; *g*, os multangulum majus; *x*, terminal phalanx, Tabūn 5; *z*, defective parts of First and Fifth metatarsals.

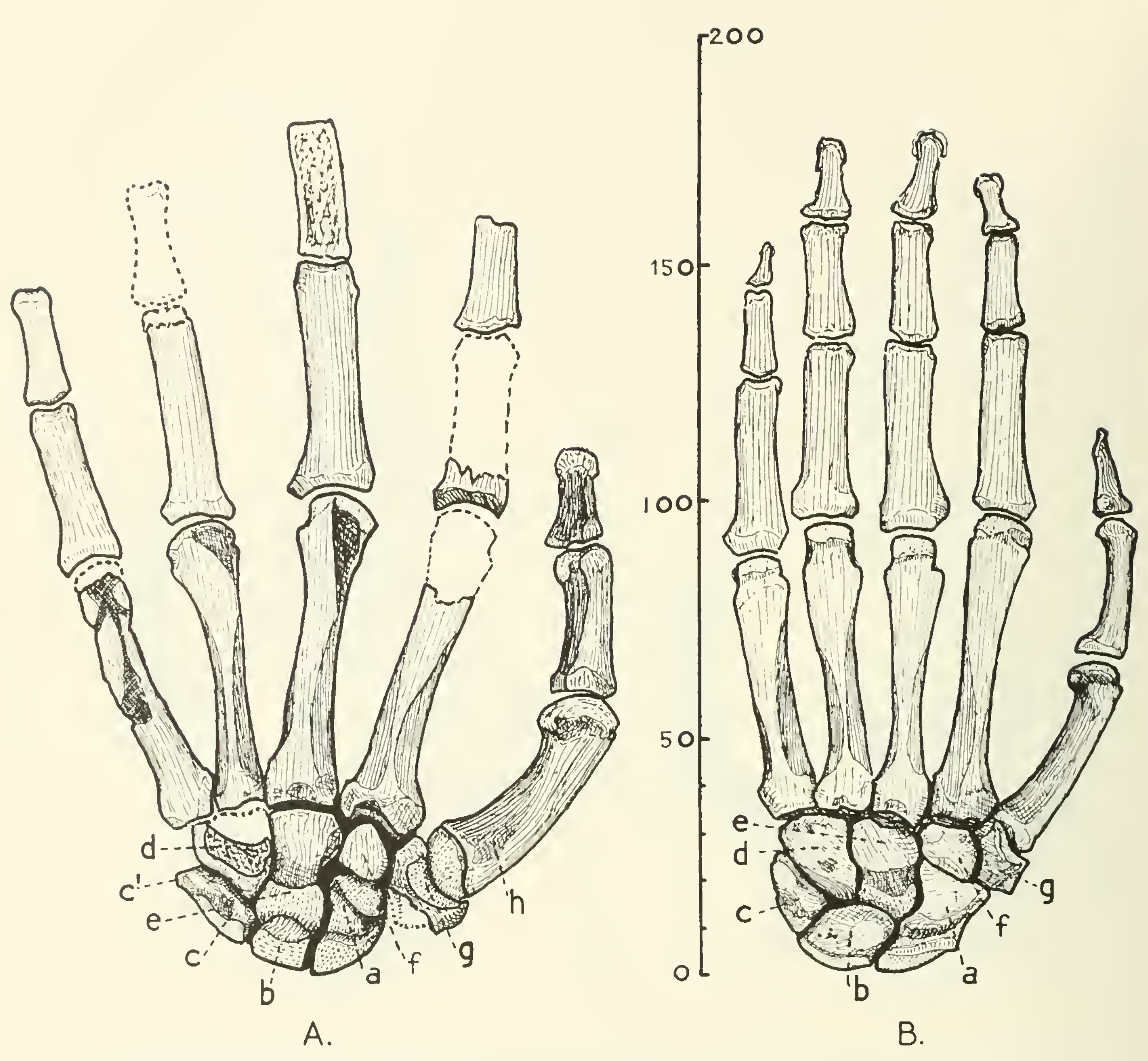


FIG. 100. DORSAL ASPECT OF THE LEFT HAND. A, Skhūl IV; B, Australian (male). The letters have the same significance as in Fig. 99. *c′*, cauda of os triquetrum; *h*, impression for the origin of the radial head of the first dorsal interosseous muscle.

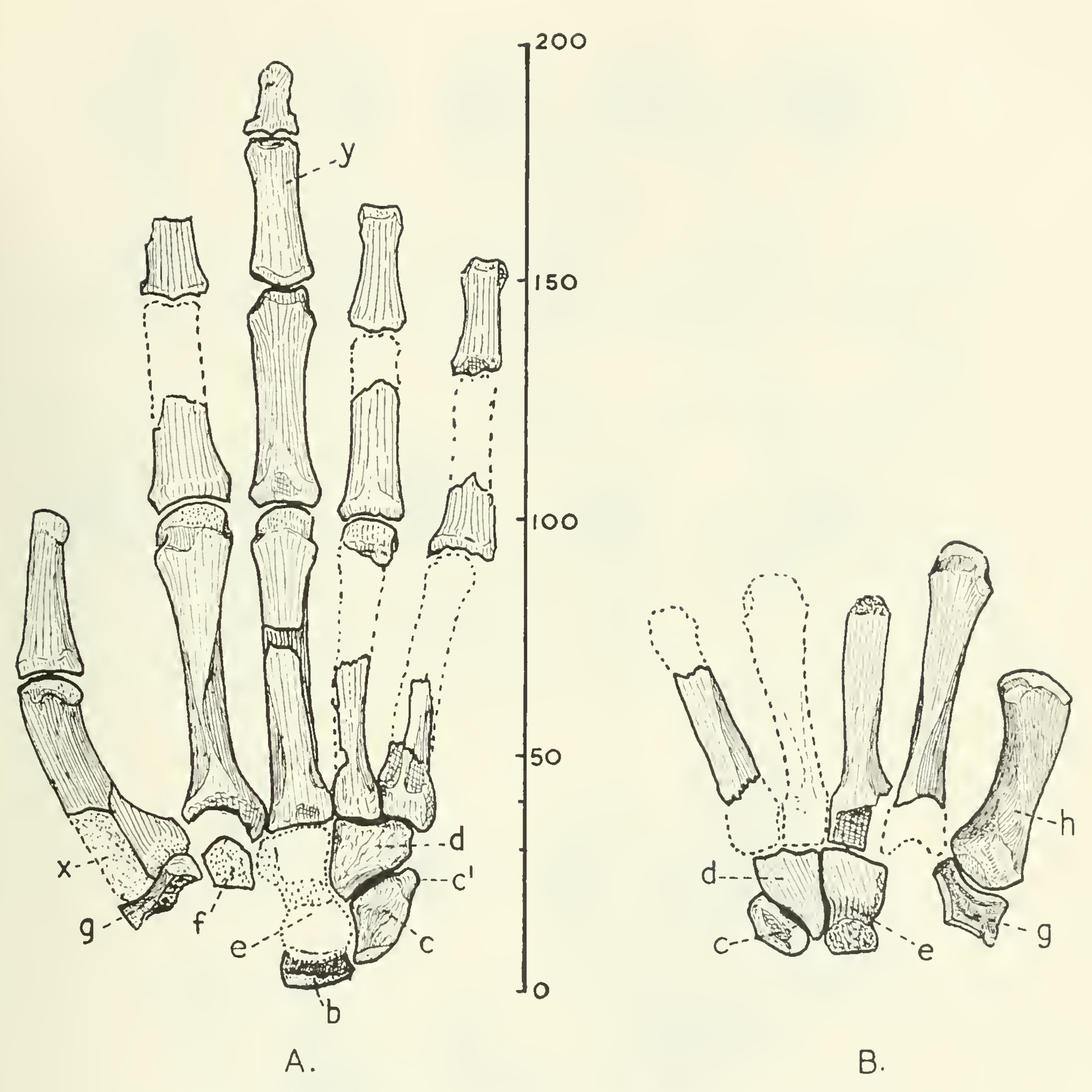


FIG. 101. DORSAL ASPECT OF THE HAND. A, Skhūl IV, right. The stippled outline of the os capitatum is the left bone, reversed. *x*, defective area of first metacarpal, the outline being taken from the left bone; *y*, middle phalanx of the left hand. B, Skhūl V, composite of right and left bones. The left bones are metacarpals III, V, os multangulum majus, os triquetrum; the right bones are metacarpals I, II, os capitatum, os hamatum (shown reversed). The outline of the fourth metacarpal is that taken from a Sikh. Letters have the same significance as in Figs. 99, 100.

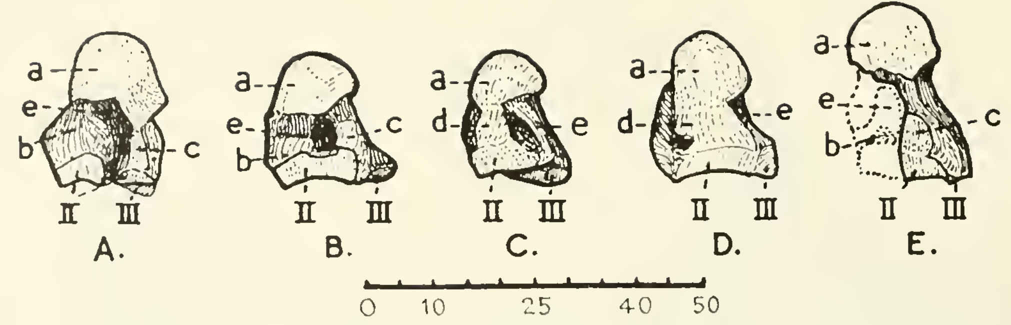


FIG. 102. THE OS CAPITATUM, LEFT BONE, LATERAL ASPECT. A, Chimpanzee; B, Tabūn I; C, Bushman; D, Sikh; E, Skhūl IV (the volar stippled part is from the right bone of Skhūl V). *a*, head; *b*, volar limb; *c*, articular area for trapezoid (multang. min.) on dorsal limb; *d*, articular area for trapezoid on volar limb; *e*, fossa between dorsal and volar limbs; II, III, articular areas for metacarpals II and III.

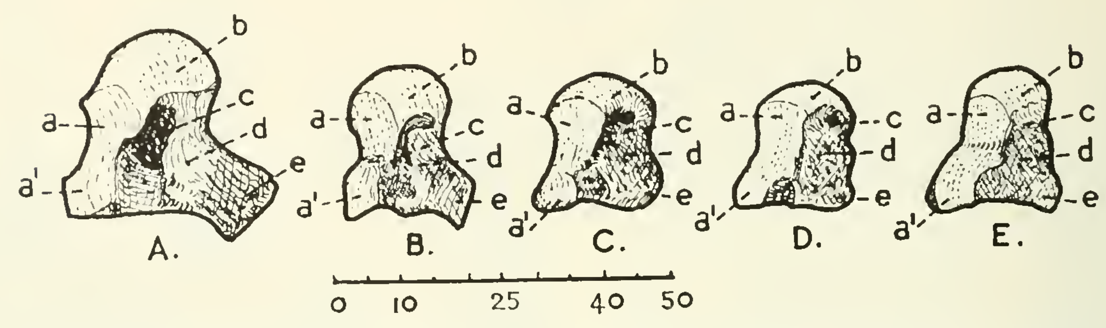


FIG. 103. THE OS CAPITATUM, LEFT BONE, HAMATO-VOLAR ASPECT. A, Gorilla; B, Chimpanzee; C, Tabūn I; D, Bushman; E, Sikh. *a*, proximal facet for os hamatum; *a′*, distal facet for os hamatum; *b*, articular area on the head for os lunatum; *c*, sub-capitular cleft or pit separating the dorsal limb from the volar limb; *d*, volar limb; *e*, volar process.

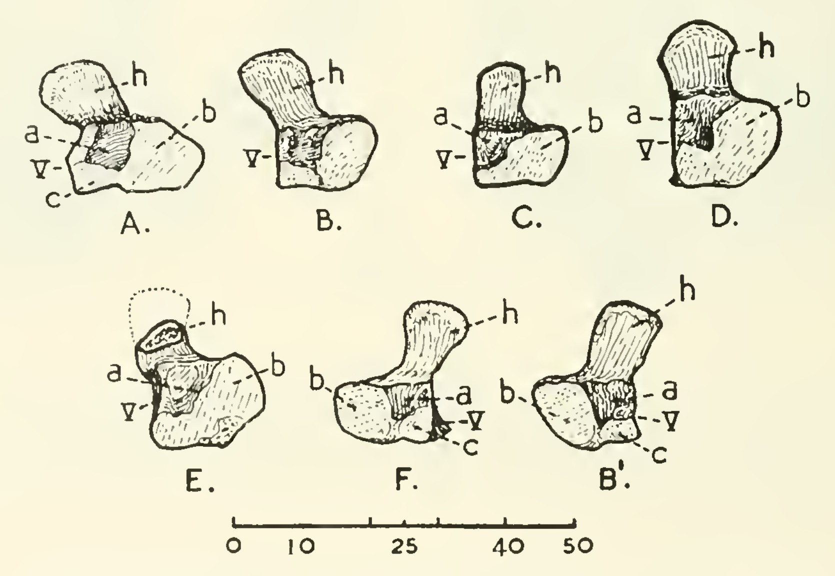
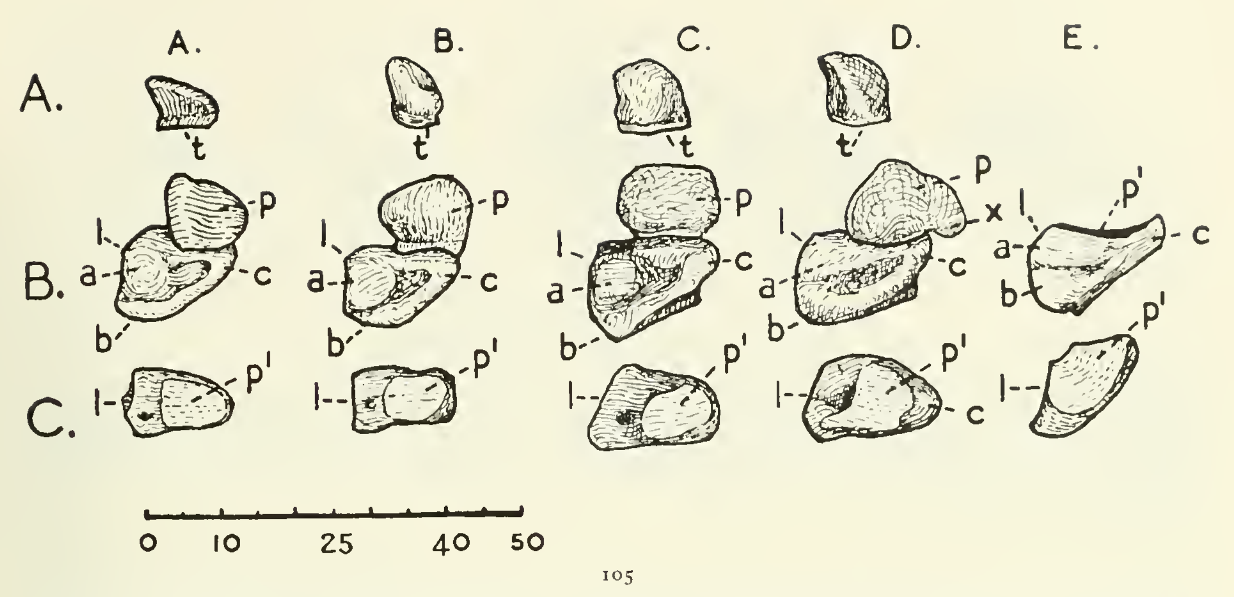
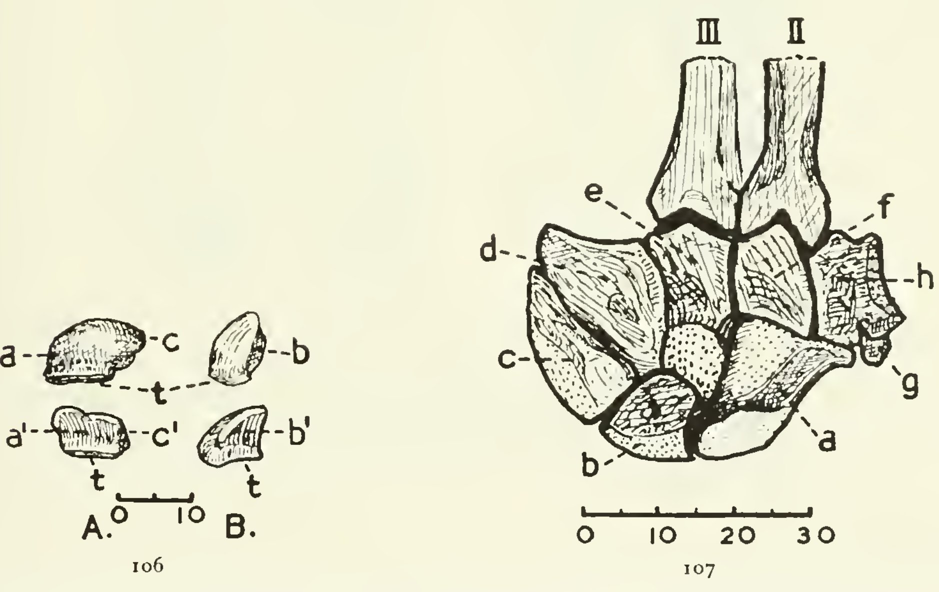


FIG. 104. THE OS HAMATUM, LATERAL ASPECT. A, Chimpanzee (left); B, Tabūn I (left); C, Bushman (left); D, Sikh (left); E, Skhūl V (right bone, reversed); F, Tabūn 3 (right); B′, Tabūn I (left bone, reversed). *a*, non-articular area; *b*, articular area for os capitatum; *c*, secondary area; *h*, hamulus; V, articulation for metacarpal V.



105

FIG. 105. THE OS TRIQUETRUM AND THE PISIFORM. A, Tabūn I; B, Bushman; C, Sikh; D, Skhūl IV; E, Chimpanzee. *A*, upper series, represents the proximal end of the pisiform; *B*, middle series, dorso-medial aspect of the os triquetrum and pisiform; *C*, lower series, volar aspect of the os triquetrum. *t*, facet for os triquetrum; *a*, articular tuberosity in contact with the meniscus; *b*, basal tuberosity; *c*, apical or caudal end of the os triquetrum; *l*, basal or lunate end; *p*, pisiform; *p'*, articular surface for the pisiform; *x*, apical process of pisiform.



106

107

FIG. 106. THE PISIFORM. A, lateral (radial) aspect of the Tabūn 4 right pisiform (upper figure) and of the Tabūn I left pisiform (lower figure). B, proximal aspect of the Tabūn 4 right pisiform (upper figure) and of the Tabūn I left pisiform (lower figure). Tabūn I shown reversed for purposes of comparison. *a*, *a'*, lateral surface; *b*, *b'*, proximal margin; *c*, *c'*, distal end,; *t*, articular base.

FIG. 107. DORSAL ASPECT OF THE LEFT CARPUS OF A CHIMPANZEE. Articular areas stippled. *a*, os naviculare; *b*, os lunatum; *c*, os triquetrum; *d*, os hamatum; *e*, os capitatum; *f*, os multangulum minus; *g*, os multangulum majus; *h*, articular surface for metacarpal I. The bases of metacarpals II and III are shown.

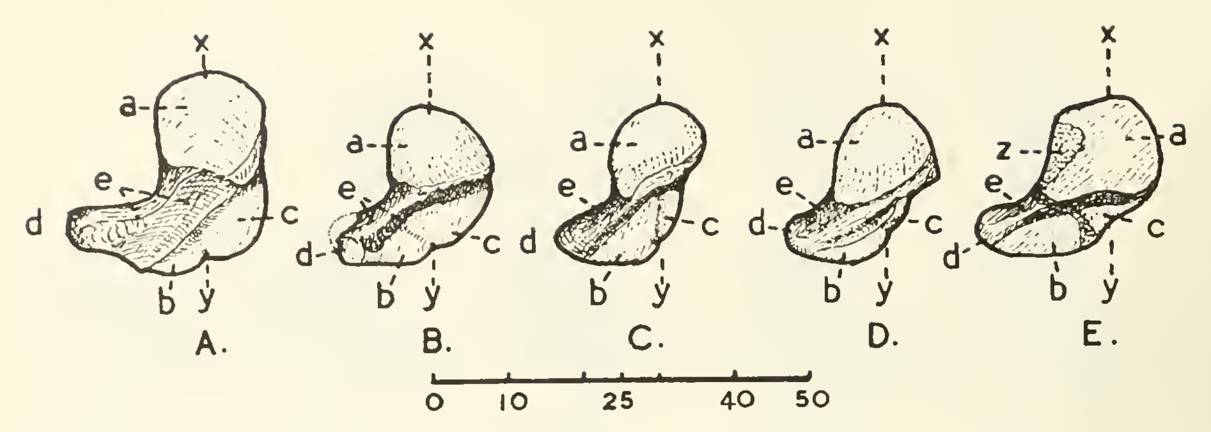


Fig. 108. The Os Naviculare, Left Bone, Dorso-Lateral Aspect (seen when the Navicular is Laid on a Table with the Volar Surface Downwards). A, Chimpanzee; B, Tabūn I; C, Bushman; D, Sikh; E, Skhūl IV. *x*, apical point of head; *y*, furrow at the distal end between the impressions for the trapezium and trapezoid (the bones are arranged on the vertical plane, *x*–*y*). *a*, radial articular surface; *b*, articular surface for the trapezium; *c*, articular surface for the trapezoid; *d*, tuberosity; *e*, dorsal non-articular area; *z*, defective area.

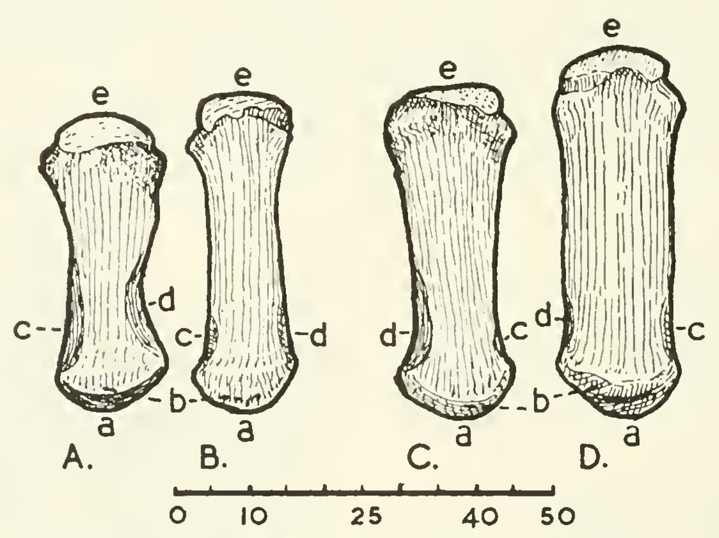


Fig. 109. The First Metacarpal, Dorsal Aspect. A, Tabūn I (left); B, Bushman (left); C, Skhūl V (right); D, Sikh (right). *a*, proximal articular end; *b*, dorsal wall of proximal articulation; *c*, origin of ulnar head of the first dorsal interosseous muscle; *d*, insertion of opponens pollicis; *e*, distal articular end.

CHAPTER XI

THE FOREARM

RADIUS AND ULNA (Pls. XII, XIII D; Figs. 110–14)

The following specimens are reported on in this section:

Tabūn I. The radius and ulna, both complete, of the left forearm. The right forearm is represented by two fragments of the middle and distal part of the shaft of the ulna, measuring together 122 mm. (Pl. XII B, *a*, C).

Tabūn 2. The distal end of a right radius, 80 mm. long. Its characters are definitely feminine. By comparing it with other fossil radii from Palestine we estimate that its original length was somewhat less than the radius of Tabūn I, about 215 mm.

Skhūl II. Proximal end of the left radius, including the tuberosity and part of the head: length 46 mm. From the ulna of the left side there is the proximal end; length 67 mm. There is 65 mm. of the shaft and head (lacking the olecranon) of the right ulna. The characters are feminine.

Skhūl IV. The bones of both forearms are almost complete (Pl. XII A, *b*, *c*). All four were rather badly split, but have been successfully repaired. Male.

Skhūl V. We have the radius of the right forearm from which the distal end is missing (Pl. XII A, *d*). The part actually present measures 236 mm. We estimate that originally the radius measured about 270 mm. The right ulna is nearly complete as to length, but both the olecranon and the distal articular extremity have been damaged. Of the left forearm we have the middle three-fourths of the shaft of the radius (185 mm.), with a fragment of the head. The left ulna is represented by the distal two-thirds of the diaphysis (195 mm.). It is to be noted that while this male is the tallest of the group, the forearms are shorter than those of Skhūl IV.

Skhūl VI. There is a fragment of the shaft of the left radius distal to the tuberosity (66 mm.); also the proximal part of the left ulna, from which the olecranon is lacking (117 mm.). Male.

Skhūl VII. The right radius is represented by three pieces, proximal end, distal end, and a middle part of the shaft (Pl. XIII D, *d*). These three pieces have a total length of 211 mm. The original articular length was about 215 mm. The right ulna is composed of two fragments, representing the proximal half of the bone and measuring together 133 mm. Of the left forearm there is the shaft and the proximal part of the radius measuring 186 mm., and the left ulna, which is practically complete save that the olecranon is damaged (see Pl. XII B, *c*).

Thus, we have three complete radii (2 male, 1 female); four complete ulnae (2 male, 2 female); seven incomplete radii (3 male, 4 female); seven incomplete ulnae (3 male, 4 female). Seven individuals are represented, four women, three men.

For purposes of comparison we have used the casts of the right radius and of the proximal fragment of the right ulna of the Neanderthal specimen. We found it necessary to study the characters of these specimens anew, some of the results being shown in our drawings of them. For the distal end of the ulna, the abnormal left Neanderthal ulna

provided us with evidence of which we stood in need. We have used the descriptions of fossil bones of the European Neanderthalians provided by Boule and by Kramberger, but unfortunately they had no complete sets of forearm bones at their disposal.

The Forearm as a Whole.

None of our predecessors have had the fortune to find a complete representation of the forearm of Neanderthal man. If they have, the results are as yet unpublished. As will be seen from Fig. 110 and Pl. XII, we are able to give a description of the forearms of three fossil individuals, two of them women, one of them a man. In Table LIII (p. 175) we give measurements of these three examples with those of other specimens for comparison. The fossil forearm repays detailed examination, for as previous observers have noted, the bones of the forearm are more liable to racial characterization than the humerus or femur.

Width of Forearm.

The forearm of the Tabūn woman was remarkably wide, the radius and ulna being greatly bowed and therefore separated. Bowing of the forearm bones is a feature of the anthropoid forearm and also of the Neanderthal limb. The width of the forearm is given in Table LIII (p. 175). In absolute measurements the chimpanzee is at the head of our list with a measurement of 58 mm.; then follow Neanderthal (*c.* 52 mm.), Sikh (50 mm.), Tabūn I (48 mm.), Skhūl IV (46 mm.), and Skūhl VII (female, *c.* 43 mm.). So bowed are the forearm bones of the Tabūn woman that her forearm is wider than that of one of the tall Skhūl men. Indeed, it is almost as wide as the forearm of the Neanderthal man (Fig. 110 A, B). If we take the articular or physiological length of the radius as representing the length of the forearm, then the ratio of width to length of forearm is 22·8 per cent. in the Tabūn woman and 22·9 per cent. in Neanderthal man. How far these amounts stand above those for the Skhūl male and for modern man will be seen from the percentages given in Table LIII, line 4 (p. 175). The index in the chimpanzee is 24·1 per cent., while the amounts for modern races vary from 20·3 per cent. in a Sikh to 16·9 per cent. in an Australian. It will be noted that the Skhūl man (IV) falls into the modern group, while the woman (VII) rises towards the Neanderthal figure. As will be seen from Fig. 110 E, the radius and ulna of this woman are as bowed as in the Tabūn woman (Fig. 110 A), while those of the man (Fig. 110 C) are as straight as in the Australian (Fig. 110 D). At first sight the Tabūn and Skhūl types of forearm seem entirely different and to be regarded as a difference of race, yet the Skhūl woman (VII) is nearer to the Tabūn than to the Skhūl type. Nor can there be any doubt of the affinity of the Skhūl male type to the modern. The Tabūn forearm bones, although they show certain affinities to the Neanderthal type of Europe, have also resemblances to the Skhūl and to the modern type.

We have been writing of the width of the forearm, taken at its widest point which is usually just distal to the insertion of the pronator teres (Fig. 110, *p. t.*), the greater curvature of the radius increasing the power of this muscle. The width measurement of the forearm is made up of two elements, a bony element representing the respective widths of radius and ulna and a space element, the interosseous space. Measurements of these elements are given in Table LIII, lines 2, 3 (p. 175); the ratio of the space element to

the articular length is given in line 5 of the Table. In the Neanderthal forearm the space ratio is 9·3 per cent. whereas in the Tabūn arm this ratio is 12·8 per cent. The bone ratio, of course, is reversed. It is 13·6 per cent. in the Neanderthal forearm, and in the Tabūn arm 10·8 per cent. The Neanderthal man has big bones, the Tabūn woman small ones. Yet her bones are more massive than those of Skhūl VII, in whom the bone-space ratio is 9·9 per cent.

The interosseous space, in the evolution of civilized and modern races, has become diminished in width not only by a straightening of the radius and ulna, but also by the growth of the bony margin to which the interosseous membrane is attached. As will be seen in Fig. 110 A, the interosseous crests are developed only in one limited area, just beyond the junction of the proximal with the middle third of the forearm. This condition was also the case in the Neanderthal forearm (Fig. 110 B). In Skhūl IV (Fig. 110 C) the area is slightly extended; it is still more so in Skhūl VII (Fig. 110 A, E). In modern races the crests extend along the ulna and radius, flanking the greater extent of the interosseous space.

Neanderthal man had massive wrists. The width of the radius and ulna at their distal ends is given in Table LIII (p. 175). Neanderthal man heads the list with a wrist breadth of 53 mm.; Skhūl IV, so much taller than Neanderthal man, had wrists of about the same dimensions. The Skhūl woman (VII) had small wrists while those of the Tabūn woman were of moderate development.

We have measured certain angles connected with the movements of the forearm. These are the angle at which the ulna is 'set' to the humerus and the angles formed between the ulna and the humerus in positions of extreme extension and of extreme flexion. The figures are given in Table LIII (p. 175). Our measurements show a wide range of variation and we have not detected any feature which is likely to serve as a means of discriminating one race from another. Other characters of the forearm, the curvature of its bones, the ratio of its length to those of the upper arm or humerus and its movement of pronation and supination are discussed in the appropriate paragraphs in the sections devoted to the radius and to the ulna.

RADIUS

There is great variation in the length of the radius. As will be seen from Table LIV (p. 176), the total length varies from 214 mm. in Skhūl VII (female) to 276 mm. in Skhūl IV (male). The mean length for Europeans (Swiss) given by Martin (1928, vol. ii, p. 1109) is 246 mm. in the male, 223 mm. in the female. In the Tabūn woman the radius measures 222 mm., almost the same as that of a Bushman with which it is compared. The radius of Skhūl IV is the longest fossil radius on record, exceeding by 6 mm. that of the tall Cromagnon recorded by Verneau. That of Skhūl VII is one of the shortest. As will be seen from Table LIV (p. 176) and our drawing in Fig. 110, the radii of the Skhūl men greatly exceed that of the original Neanderthal man. Indeed, the radii of the Neanderthalians of western Europe are short, stout bones.

In the western Neanderthalians the forearm is short, especially in comparison with the upper arm. Boule found that the radius in the La Ferrassie woman measured only 70 per cent. of the length of the humerus; in the La Ferrassie man, 74 per cent. According to measurements made on the casts, the radius of Neanderthal man is 75·8 per cent. of

the humeral length. The proportion is 77·3 per cent. in the Tabūn woman, while it rises to 81·8 per cent. in Skhūl IV, an amount common in black races. In a Bushman used for comparison the ratio was 80·6 per cent., in an Australian 80·3 per cent., in a Sikh 78·1 per cent. A glance at Table LIV, line 4 (p. 176), will show that the range of the length ratio of radius to humerus among the Palestinians agrees with what might be found in a group of Europeans. These values are not Neanderthaloid, in the strict sense of that term.

There is, however, one remarkable exception, that of the tall male, Skhūl V. Although the femur of this man exceeds that of Skhūl IV by 24 mm., yet his radius is shorter by about 8 mm. The radius of Skhūl V is only 70·5 per cent. of the humeral length, a Neanderthalian proportion. It is also to be remembered that in this individual the leg was short in relationship to the thigh.

In the quality of robustness, measured by the ratio of least circumference to the physiological length of the radius (Table LIV, lines 5, 6, p. 176) the Neanderthal radius reaches the high ratio of 18. In the Sikh, whose bones serve as a modern standard, this ratio is exceeded, as it is in the radius of the Skhūl child. In the Skhūl adult bones the ratio varies between 15·1 and 16·1; in the Australian male it is 15·5; in the Bushman 14·4. Thus, in point of robusticity, the Palestinian radii agree with those of the modern primitive races, while those of Neanderthal man are similar to the ratios found in the radii of the labouring classes of modern Europeans. The right radius of the Palestinians is consistently stouter than the left, an evidence of their righthandedness.

Another feature of the European Neanderthalians is that the neck of the radius is relatively long. This is also true of the Palestinians. As will be seen in Table LIV (p. 176), the neck lengths are absolutely and relatively great. The ratios range between 13·5 in Skhūl V and Tabūn I to 15·3 in Skhūl VII. The neck ratio in the Neanderthal radius is 13·8. In the Sikh radius it was as low as 9·3 but in the Bushman it rose to 13·2. A long radial neck is a primitive feature, which the Palestinians share with the Neanderthalians of Europe.

Shaft of the Radius.

In Table LV (p. 176) is given the medio-lateral and the dorso-volar diameters of the shaft as well as the ratio of the latter to the former. The absolute and relative amounts in the Palestinians are in no way remarkable. The diameters of the long radii of the Skhūl men are very near to those of the Neanderthal radius, but in the Skhūl males there is a tendency towards roundness of the shaft, with the dorso-volar diameter ranging from 77 to 86 per cent. of the medio-lateral. The Tabūn radius is relatively flat. The radius recorded from the Krapina people corresponds to the more slender bones of our Palestinians. Indeed, the Krapina people, in the characters of their limb bones, show many affinities to our smaller people.

Measurements of the curvature of the radius are given in Table LV, lines 5, 6, 7 (p. 176). These serve to amplify what we have already written when dealing with the forearm as a whole (p. 166). The degree of curvature, as indicated by the ratio of the subtense to the chord of the curvature, reaches its maximum in two specimens, that of Neanderthal (5·4) and that of the Tabūn woman (5·8). These figures are approached by Skhūl VII with a ratio of 4·6. The radii of the Skhūl men show remarkably little curvature, with

values of 1 and 2·4, similar to those found in such modern primitive races as the Australian and the Bushman.

The measurements of another feature related to the shaft are given in Table LV (p. 176). This is the angle formed by the neck with the proximal part of the shaft. The angle, open laterally, is low in Tabūn I and Skhūl VII (both women), where it measures 165°–166°, but the inter-racial range of this feature varies from 155° to 177° and it is of small diagnostic value.

Proximal End of Radius.

The maximum diameters of the head and neck are given in Table LVI, lines 1, 2 (p. 176), and the ratio of the neck to the head in line 3. As is well known the neck of the radius in Neanderthal man is small in comparison to that of the head. In the Neanderthal radius the neck is 56 per cent. of the width of the head. The proportion is only 51·2 in the Tabūn radius, but the racial significance of this is rendered doubtful by the fact that in the radius of a Bushman it is the same. It is also low in the Skhūl woman (VII) where it is only 52·6 per cent. in the left bone. In the Skhūl male (IV) the figure, 68 per cent., rises towards that which prevails in modern races. In the Sikh, a representative of a civilized race, it is 69·5 per cent. Here in the Palestinian series we have a transition from 51·2 to 68 per cent., from an ultra-Neanderthal to a modern relationship. In the Krapina radii the diameter of the head varied from 19·6 to 23·2 mm., which falls within the range of our series. In La Chapelle man it measured 24 mm., the same as in Skhūl IV (left), but then it must be remembered that the Skhūl radius is the longer by 32 mm. Our measurements at the level of the tuberosity gave only negative results.

Distal End of the Radius.

There are given in Table LVI, lines 4, 5, 6 (p. 176), the diameters of the distal end of the radius with the ratio of the medio-lateral to the dorso-volar diameter. Although the proximal end of the radius gave identical measurements in the Tabūn and Bushman bones, at their distal ends the Tabūn figures are the greater. The diameters of the distal end of the right radius of Skhūl IV are slightly greater than those of the Neanderthal specimen, but when we take into consideration their respective lengths (Table LVI, line 7, p. 176) the ratio of the width is much lower, 13·6 as against 15·8 for the Neanderthal bone. The ratio for the Tabūn radius is 14·7; in Skhūl VII, 13·3; in the Bushman, 12·9; in the Australian, 12·6; in the Sikh, 13·9. Thus, in the size of their distal ends the Skhūl radii agree with those of modern races, while the Tabūn radius, as usual, shows Neanderthaloid affinities.

We also give the angle which the transverse axis of the radiocarpal joint (Table LVI, line 8, p. 176) makes with the axis of the distal half of the radial shaft. We obtain a range from 66° in the Tabūn radius to 77° in Skhūl VII. The angle in the Neanderthal radius is 76°, approximately the same as in the Sikh.

Torsion of Radius.

In the later evolution of man the radius and ulna have undergone certain changes in connexion with the perfecting of the movements of pronation and supination. Those connected with the ulna are described on pp. 173–4; here we deal only with certain changes

in the radius which are illustrated in Fig. 111. In these drawings the carpal end of the left radius is reproduced in the stage of semi-pronation, with the transverse axis of the radiocarpal joint in an upright or vertical position. The corresponding positions of the tuberosity of the radius, with the area for insertion of the biceps muscle (*ta*) are reproduced in the upper series of the diagrams. The position of the parts in the radius of Neanderthal man (Fig. 111 C) is very simple. The tuberosity of the radius is directed downwards, in the direction of the axis of the radiocarpal joint. The area of the attachment of the biceps to the tuberosity lies behind the upright plane, dorsal to the interosseous plane. In this position the plane of the curvature of the radius lies in the vertical plane of the radiocarpal joint, the position which gives the supinator brevis and the pronator teres their greatest leverage. The position of the parts is very similar to that in the chimpanzee (Fig. 111 D). In the Australian radius a modern condition is represented (Fig. 111 A). Torsion has taken place so that the tuberosity no longer faces the proximal radio-ulnar joint, but looks forwards as well as downwards on the flexor aspect of the forearm. This change in the situation of the tuberosity gives the biceps greater power in the middle and later stages of supination. A similar series of changes are seen in the radius of the Tabūn woman (Fig. 111 B).

The drawings in Fig. 111 also serve to bring out one of several features in which the forearm of the Tabūn woman shows chimpanzee-like characters. If Fig. 111, B and D, are compared it will be seen that in both the distal head of the ulna is large and of similar shape, while the cross-section of the radius is relatively small. The head of the Neanderthal ulna is also large.

ULNA

In Table LVII (p. 177) we give the various measurements of length of the ulna; it is not necessary to discuss them as they lead to conclusions already reached in the paragraphs dealing with the forearm and the radius. There are three points brought out in Table LVII which are worthy of mention. The first relates to the length of the olecranon process, the lever of the triceps, and the proportion which this forms to the articular or physiological length (Table LVII, lines 4, 5). In the chimpanzee this process is short; it forms only 6·2 per cent. of the articular length. In the Neanderthal ulna this becomes 12·2 per cent., a very high figure which is not reached in any Palestinian specimen. In the proportions of their olecranon the latter are modern. Even in the Tabūn woman, who possesses so many Neanderthal traits, the olecranon is 9 per cent., the same as in the Bushman ulna. Indeed, a glance at Table LVII will show how closely the ulnae of these two agree. But if we take the whole height or length of the proximal articular end, measured from the lower margin of the radial notch to the upper limit of the olecranon, then the Neanderthal character of the Tabūn ulna again becomes manifest (Table LVII, lines 8, 9). The proximal end of the Tabūn ulna represents 18·5 per cent. of the articular length, almost as much as in the Neanderthal bone. The Skhūl ulnae fall into the modern series, ranging from 14·3 to 16·1. The proportion is low in the chimpanzee, 14·8 per cent.

The ulnar index of robusticity may vary independently of the radial strength. The data relating to this feature of the Palestinian ulnae are given in Table LVII, lines 6, 7 (p. 177). Here the Neanderthal ulna is at the top of the series, 16·6 per cent., that of the

chimpanzee at the bottom with 11·8 per cent. Between these extremes lie those relating to the Palestinian fossil ulnae and the modern specimens. In point of robusticity the Tabūn ulna is similar to the Bushman's.

Olecranon Process.

As the olecranon end of the ulna is often preserved in fossil finds, much attention has been given to its various dimensions. We have given the principal measurements in Table LVIII (p. 177), but the results are relatively barren. The olecranon process is exceptionally massive in Neanderthal man. So far as concerns the dimensions of the semilunar notch—the articular surface which receives the trochlea of the humerus—there is little which calls for notice. The development of the beak or cap of the olecranon, however, is a distinctive feature. It is little developed in the chimpanzee and modern races. In this point the Skhūl ulnae are modern but the Tabūn ulna is not. It has a cap (Table LVIII, line 3), which approaches in size that of the Neanderthal ulna. The olecranon cap is not a primitive feature; it is a specialization which appears in the Neanderthal group of races.

The olecranon is wide in Neanderthal man. In Skhūl IV it is slightly narrower than in the Neanderthal ulna (Table LVIII, line 4, p. 177), but then the articular length of the Skhūl ulna is 34 mm. longer. The width of the olecranon in the Tabūn ulna is the same as in the Bushman. In Spy II, the width of the olecranon was 26 mm.; in Spy I (female) 20·6 mm., rather less than in the Tabūn woman, and in a Krapina ulna it measured 24·2 mm.

From drawings of the proximal end of the ulna, viewed in profile (Figs. 112, 114), there will be observed a varying relationship between the heights, or forward projections, of the olecranon and coronoid processes. These projections are recorded in Table LVIII, lines 5, 6, 7 (p. 177). For example, in the Sikh ulna, which exemplifies features to be seen in the ulnae of civilized races, the depth (projected) of the olecranon is 27 mm., the coronoid, 37 mm. The projection of the coronoid is 37 per cent. greater than that of the olecranon. In the chimpanzee this ratio is 19 per cent., in Neanderthal 26 per cent., in Tabūn I 10 per cent., in Skhūl VII 21 per cent., in Skhūl IV 41 per cent., in the Bushman 35 per cent., and in the Australian it is 38 per cent. A predominance of the coronoid over the olecranon is a modern feature; it is present in the ulna of Skhūl IV but is absent in Tabūn, Skhūl VII, and in the Neanderthal bone. But this is not always the case. From data given by Kramberger (1906, p. 229) we infer that there was a coronoid projection of 45 per cent. in Spy I (female), certainly a member of the European Neanderthalians. On the other hand the projection in a Krapina specimen was 16 per cent. and in the Spy man (II), 18 per cent.

Curvature of the Ulna.

Curvature of the ulna, as of the radius, is a means of increasing the leverage of the muscles concerned in supination and pronation, but the increase of power is accompanied by slowness of movement. In dealing with the forearm we have already mentioned the extreme widths found in the Tabūn woman and in Skhūl VII. The data relating to the curvature of the ulna are given in Table LIX (p. 177). Unfortunately there is no exact

record of the curvature of the ulna of Neanderthal man. The left Neanderthal ulna has been severely injured in youth and is straight; the proximal part only of the right bone is preserved. It shows curvature but to a lesser degree than in the ulnae of Tabūn I and Skhūl VII. In the latter the ulna is even more curved than that of a chimpanzee but the ulna of the Skhūl males is as straight as in the civilized races of modern man. Had only the bones of the Tabūn woman and Skhūl IV been discovered we should have been inclined to regard curvature of the forearm bones as a feature which distinguished the Tabūn people from the Skhūl people. But the Skhūl woman (VII), certainly a member of the Skhūl community, shows a degree of curvature greater even than in the Tabūn forearm. Yet it will be noted that in robusticity and other features the Tabūn specimen is the more Neanderthaloid.

In Table LIX, line 4 (p. 177), data relating to the curvature are obtained by a method described in a note to that Table. These measurements represent not only the anterior or flexor curvature of the ulna but also the degree of projection of the coronoid process and of the distal extremity of the shaft. Even measured in this way the ulna of Skhūl VII is highest in the scale of curvature.

In Table LIX (p. 177), we give measurements of two more features of the ulna. One is the angle which the axis of the trochlear ridge forms with the axis of the proximal part of the shaft of the ulna. This is another method of estimating the angle at which the forearm moves on the upper arm. The angle is very small in the Neanderthal ulna. The same is true of the Tabūn ulna and to a certain extent also in Skhūl VII. The angle varies much with the individual.

Other data in Table LIX (p. 177) relate to the dimensions of the notch for the reception of the head of the radius. As will be seen (Table LIX, lines 6, 7), the radial notch has almost the same absolute and relative dimensions in the Tabūn ulna as in the Bushman. In both cases the vertical diameter is great, forming 90 per cent. or more of the transverse diameter. In the ulna of modern civilized and some primitive races the notch tends to diminish in its vertical diameter and increase in its transverse. In the Sikh, for example, the vertical diameter is 63 per cent. of the transverse. Some of the Skhūl ulnae show a tendency towards this diminution of the vertical diameter.

Shaft of the Ulna.

Measurements are given in Table LX (p. 178) relating to the diameters of the ulnar shaft. Flattening of the shaft may be more apparent in figures than in reality. The growth of the interosseous crest increases the transverse measurement without adding to the strength of the bone. The absolute measurements are more instructive, therefore, than the relative ones, especially those of the dorso-volar diameter. A glance at Table LX, line 2, reveals the preponderance of this diameter in the Skhūl males. In the Neanderthal ulna the transverse diameter is much as it is in the Skhūl males but the dorso-volar is less. The Skhūl ulnae have smooth borders and a rounded form. In the ulnae of two of the females (Skhūl II, VII) the borders are as definitely marked as in native races to-day.

Measurements relating to the distal end of the ulna are given in Table LX, lines 7, 8, 9 (p. 178). The ridge for the origin of the pronator quadratus, in the distal fifth of the ulna, is particularly well developed in the Palestinian specimens. The measurements

reveal nothing, however, which serves to distinguish them from the ulnae of primitive races of modern man.

We have already drawn attention to the large size of the carpal end of the Neanderthal ulna; the development of the chimpanzee's ulna is also great (Fig. 111 D). We give the width (Table LX, line 9, p. 178) of the head or distal end of the ulna, this being usually the maximum diameter, although in the Tabūn ulna both diameters are nearly equal. The measurements of the shaft of the Tabūn ulna usually agree with those made on a Bushman's ulna, but as regards size of the distal head they differ, the Tabūn specimen having a large head, relatively nearly as great as in the Neanderthal ulna. In absolute width the carpal ends of the ulnae of the Skhūl males are the equals of the Neanderthal specimen, but relative to the length of shaft they are smaller, thus agreeing with modern races.

Evolutionary Changes in the Coronoid Region of the Ulna.

Measurements relating to the coronoid region of the ulna are given in Table LX, lines 4, 5, 6 (p. 178). They are made in a plane which crosses the ulna at the lower (distal) border of the radial notch. It is a region which is liable to an extreme degree of racial and individual variability. The nature of this variability will best be realized by examining the drawings given in Figs. 112, 113. The primitive condition appears to be that represented by the Tabūn ulna—and also the Bushman ulna—where the transverse diameter is a little over 102 per cent. of the dorso-volar diameter of the coronoid region. The Skhūl ulnae show an increase in the dorso-volar diameter, which may be regarded as a movement towards the state which prevails amongst modern races.

The fact that the dorso-volar diameter in the ulna of the chimpanzee is much greater than the transverse (in the coronoid region) seems to contradict what we have just written. The eurylenia of the chimpanzee is of a different nature from that found in the Skhūl, Australian, and Sikh ulnae; it is due not to an increase of its substance in a dorso-volar direction, but to the narrowness of its development in a transverse direction. There is a true eurylenia and a false eurylenia; true eurylenia is due to a filling up of the pre-coronoid area of the ulna with new bone. By this means the area for the insertion of the brachialis becomes transformed.

We have previously mentioned the anatomical changes in the radius and ulna which have accompanied the perfection of pronation and supination in man's forearm. The significance of the thickening of the ulna in the pre-coronoid region and the changes in the whole of the coronoid area appear to be chiefly concerned with the greater control of the forearm during flexion and extension. These changes are illustrated in Fig. 112 A, B, C, D, beginning with the condition found in the chimpanzee and ending with one representative of modern civilized man. It is necessary to distinguish four elements in the coronoid complex: the articular process (*c*); the main or principal supporting ridge (*r*); the medial ridge (*r'*), and the area for the insertion of the brachialis muscle (*br*). Fig. 112 reveals the progressive series of changes. Clearly the stage represented in the Tabūn ulna is the lowest human stage yet seen; it leads on to the condition seen in the ulna of the Australian.

Further illustrations of the evolution of the coronoid complex are given in Fig. 112 E, F, G, H. The stage seen in Skhūl IV (E) is very similar to that in the Australian ulna (Fig. 112 C), while that of Skhūl VII approaches very closely a form seen in modern

ulnae. In the Neanderthal ulna (Fig. 112 H), we have a primitive, yet a specialized condition, much less anthropoid in character than that of the Tabūn woman. Yet in a Skhūl woman (Skhūl II) (Fig. 112 G), the condition is similar to that seen in the Neanderthal ulna. It seems to us that in the Tabūn ulna we have a very primitive stage, and that in the Skhūl ulnae we have all the stages leading from the Tabūn to the modern condition. One has but to compare the study we have made of the Neanderthal ulna (Fig. 112 H) to realize how peculiarly specialized is the Neanderthal type.

To appreciate the nature of these changes in the coronoid region, the part which the ulna plays in pronation and supination has to be remembered. The proximal and distal ends of the ulna provide the fixed basis on which the rotatory movements of the radius are executed. The chief force concerned in rendering the ulna fixed, in all stages of flexion of the elbow, is the tonic or static action of the brachialis. The evolutionary changes in the coronoid complex are related to the increasing precision in the use of the forearm for finer manual purposes.

To illustrate further the important series of changes in the coronoid region of the ulna we give a series of transverse sections in Fig. 113. The sections were made across the ulna at two levels, 10 mm. below the radial notch (*A*, *B*, *C*, &c.), and at a higher level, across the radial notch, 5 mm. below the free border of the coronoid process (*A'*, *B'*, *C'*, &c.). The sections were made so as to bring the medial border (*m*) and the lateral ridge (*l*, *l'*), which represents the supinator ridge, into the same transverse plane. The gradual upbuilding of bone in front of these ridges can be traced from the stage represented in the chimpanzee to that found in the ulna of the Sikh. The close resemblance of the chimpanzee (A, A') and the Tabūn (D, D') sections will be noted, and the profound manner in which they differ from the Neanderthal ulna (B, B'). Clearly the condition in Skhūl VII (G, G') marks a stage above that seen in the Tabūn ulna. The resemblance of the sections of Skhūl VII to those of the Bushman (F, F') are striking; in this, as in many other features, the Bushman possesses a primitive trait. On the other hand, the sections of Skhūl IV (E, E') show a transition from the Tabūn forms to those seen in modern ulnae.

When we turn to the lateral aspect of the proximal end of the ulna (Fig. 114), we find evidence of other evolutionary changes in the Palestinian series. To fix the ulna, the brachialis must have an opposing extensor. This is the triceps muscle inserted into the tricipital area of the olecranon, seen in the drawings in Fig. 114, *t*. In the chimpanzee (Fig. 114 A) the chief use of the triceps is to serve in suspension and in brachiation. Hence the olecranon is short and lies below the level of the articular beak. Bone has been added in the Tabūn olecranon giving the triceps increased power when the elbow is flexed. In Fig. 114 A, B, C, D we see four stages in the evolution of the strong proximal end of the modern bone. If Fig. 112 be examined, it will be seen that with this increase of the tricipital area of the olecranon there has been a corresponding diminution in another area, which we designate as the medial tuberosity of the olecranon (Fig. 112, *x*).

Another series of changes affects the radial notch, its posterior part being thrown outwards by an increase of the scaffolding of bone which supports it.

A comparison is made in Fig. 114 E, F, G, H between the Skhūl types and the type represented by the proximal end of the normal (right) ulna of the Neanderthal man. The Neanderthal bone shows a primitive feature which is absent in all the Palestinian

ulnae. A long ridge (*m*) will be seen to descend from the olecranon to the dorsal border of the shaft of the ulna. It marks the margin of the insertion of the anconeus muscle. It is very evident in the ulna of the chimpanzee (Fig. 114 A). In all the other specimens the anconeus has extended its origin upon the subcutaneous area of the ulna so that the anconeal margin is seen only at its proximal end. The anconeus has undergone an expansion to help the triceps in fixing the ulna. It will be noted that in this, as in many other points, the Tabūn ulna agrees with the Skhūl specimens and differs from that of Neanderthal.

Summary.

We have dealt with the bones of the forearm at some length because of the discovery in the Palestinian radius and ulna of a series of evolutionary changes which bridge the gap between the anthropoid and the highest human states. These changes are connected with the evolution of the finer movements of pronation and supination. They concern the curvature of the shafts and the modification of the proximal and distal ends of the radius and ulna.

Our comparison emphasizes the differences between the Neanderthal people of western Europe and the Palestinians. The Neanderthal type of Europe, in spite of the presence of many primitive (anthropoid) traits yet shows many specializations, some of them of a retrograde nature.

Amongst the Palestinians we have two types of forearm bones: that represented by the Tabūn woman and the other by the Skhūl people. The Skhūl people in their forearms are modern, yet some of them, particularly Skhūl VII, show features which link their type to the Tabūn type. We might point out that this is the first opportunity anthropologists have had of making a study of the forearm of mid-Pleistocene humanity on a complete series of bones.

Table LIII. THE FOREARM

	Tabūn I	*Skhūl VII*	*Neanderthal**	*Australian*	*Skhūl IV*	*Sikh*	*Bushman*	*Chimpanzee*
	L	L	R	L	L	R	L	L
Maximum width forearm†	48·0	(43·0)	(52·0)	43·5	46·0	50·0	42·0	58·0
Radius-ulna component of width	21·0	20·0	31·0	26·5	29·0	32·0	23·0	25·0
Interosseous space component of width	27·0	23·0	21·0	17·0	17·0	18·0	19·0	33·0
Ratio:								
maximum width forearm to articular length	22·8	21·2	22·9	16·9	17·6	20·3	19·6	24·1
interosseous space to articular length	12·8	11·3	9·3	6·6	6·5	7·2	8·8	13·7
Width of distal end of forearm‡	44·0	41·0	53·0	45·0	52·0	48·0	40·0	47·0
Angle of:								
Forearm to arm§	177·5°	..	172·5°	160·0°	172·0°	170·0°	170·0°	158·0°
Forearm in extreme extension‖	152·5°	..	158·0°	159·0°	165·0°	159·0°	153·0°	175·0°
Forearm in extreme flexion‖	24·0°	..	29·0°	8·0°	29·0°	28·0°	10·0°	24·0°

* All measurements in this and Tables LIV–LX are made on the casts.
† Measured from medial border of ulna to lateral border of radius, usually a little distal to the mid-point.
‡ Measured just proximal to the distal ends of the radius and ulna.
§ The angle, opening laterally, at which the ulna is 'set' to the humerus.
‖ The angle, opening ventrally, formed by the long axes of the ulna and humerus.

Table LIV. RADIUS

	Tabūn I	*Bush-man*	*Tabūn 2*	*Skhūl IV*		*Skhūl V*		*Skhūl VI*	*Skhūl VII*		*Nean-der-thal*	*Aus-tra-lian*	*Sikh*
	L	L	R	R	L	R	L	L	R	L	R	R	R
Length:													
total (or of part preserved) M 1	222·0	224·0	80·0	276·0	272·0	236·0	185·0	66·0	(211·0)	(186·0)	238·0	269·0	258·0
estimated	..	..	215·0	..	274·0	268·0	..	..	..	214·0	..	..	..
articular M 2	210·0	214·0	..	260·0	(257·0)	(258·0)	..	..	..	(202·0)	227·0	258·0	246·0
Radio-humeral-total length index	77·3	80·6	..	81·8	81·0	70·5	..	..	..	76·4	75·8	80·3	78·1
Least circumference M 3	32·0	31·0	32·0	43·0	(42·0)	39·0	38·0	(41·0)	33·0	32·0	41·0	40·0	45·0
Index of robusticity	15·2	14·4	..	16·5	16·3	15·1	..	..	..	15·8	18·0	15·5	18·2
Length of neck M 1*a*	30·0	32·0	..	38·0	39·0	(35·0)	..	..	32·0	31·0	33·0	31·0	24·0
Ratio of neck to articular length	13·5	13·2	..	14·6	15·1	13·5	..	..	..	15·3	13·8	11·5	9·3

Table LV. RADIUS

	Tabūn I	*Bush-man*	*Tabūn 2*	*Skhūl IV*		*Skhūl V*		*Skhūl VI*	*Skhūl VII*		*Nean-der-thal*	*Aus-tra-lian*	*Sikh*
	L	L	R	R	L	R	L	L	R	L	R	R	R
Shaft diameters:													
medio-lateral M 4	13·5	12·0	(11·0)	(16·0)	(14·0)	15·0	15·0	(15·0)	12·0	12·0	16·0	13·0	17·0
dorso-volar M 5	9·2	8·5	(8·0)	(13·0)	(12·0)	13·0	12·0	(11·0)	10·0	9·0	12·0	12·0	13·0
Shaft index*	68·1	70·8	..	81·2	85·7	86·6	80·0	..	83·3	75·0	75·0	92·3	76·4
Curvature of lateral border:													
length (chord) M 6	172·0	164·0	..	205·0	..	(205·0)	(135·0)	..	..	(160·0)	165·0	214·0	190·0
height (subtense)	10·0	4·0	..	2·2	..	(5·0)	(3·0)	..	..	(7·5)	9·0	3·0	6·0
Ratio of height to length of chord	5·8	2·4	..	1·0	..	2·4	2·2	..	..	4·6	5·4	1·4	3·1
Neck-shaft angle M 7	165°	172°	..	167°	169°	(174°)	..	..	165°	167°	167°	168°	170°

* Shaft index: ratio of the dorso-volar to the medio-lateral diameter.

Table LVI. RADIUS

	Tabūn I	*Bush-man*	*Tabūn 2*	*Skhūl II*	*Skhūl IV*		*Skhūl V*	*Skhūl VII*		*Nean-der-thal*	*Aus-tra-lian*	*Sikh*
	L	L	R	L	R	L	R	R	L	R	R	R
Maximum diameter of:												
head	19·5	19·5	..	(20·0)	(25·0)	24·0	(22·0)	(18·5)	19·0	23·5	22·0	23·0
neck	10·0	10·0	..	11·5	17·0	16·0	(18·0)	(10·5)	10·0	13·2	14·0	16·2
Ratio of neck to head	51·2	51·2	..	57·5	68·0	66·6	..	56·7	52·6	56·1	62·2	69·5
Diameters of distal end:*												
medio-lateral M 5 (6)	31·0	29·0	30·0	..	..	35·0	..	27·0	..	36·0	34·0	36·0
dorso-volar	20·0	20·5	18·0	..	..	26·0	..	19·0	..	24·5	25·0	25·0
Distal end index†	64·5	70·6	60·0	..	73·0	74·3	..	70·3	..	68·0	73·5	69·4
Ratio of distal width to articular length	14·7	12·9	..	..	14·2	13·6	..	13·3	..	15·8	12·6	13·9
Carpo-shaft angle‡	66°	73°	70°	..	72°	68°	..	77°	..	76°	70°	77°

* Both diameters are taken on the measuring board. The width is measured between the most projecting medial and lateral points, with the volar surface resting on the board. The dorso-volar diameter is taken with the volar surface placed against the vertical wall of the board.

† Distal end index: ratio of the dorso-volar to the medio-lateral diameter.

‡ The angle formed by the long axis of the radiocarpal surface with the axis of the distal part of the radial shaft.

Table LVII. ULNA

	Tabūn I	*Bush-man*	*Nean-der-thal*	*Skhūl IV*		*Skhūl V*		*Skhūl VII*	*Aus-tra-lian*	*Sikh*	*Chim-pan-zee*
	L	L	R	R	L	R	L	L	R	R	R
Length:											
total (or of part preserved) M 1	243·0	237·0	150·0	290·0	293·0	270·0	196·0	239·0	287·0	274·0	270·0
estimated	..	..	(260·0)	(294·0)	..	(272·0)	(270·0)	..	..	..	..
articular M 2	210·0	209·0	(228·0)	262·0	(262·0)	(236·0)	(236·0)	203·0	252·0	247·0	240·0
Height of olecranon M 8	19·0	19·0	28·0	(20·0)	20·0	(20·0)	..	(17·0)	21·5	21·0	15·0
Ratio: height of olecranon to articular length .	9·0	9·0	12·2	8·4	7·5	8·4	..	8·3	8·5	8·5	6·2
Least circum. M 3	29·0	29·0	38·0	40·0	37·0	37·0	35·0	28·0	31·0	38·0	28·5
Index of robusticity	13·8	13·8	16·6	15·3	14·1	15·6	14·7	13·7	12·3	15·3	11·8
Height of proximal joint M 5 (1) . . .	39·0	35·0	43·0	(40·0)	39·0	(38·0)	..	(35·0)	38·0	41·0	35·5
Ratio of joint height to articular length . .	18·5	16·7	18·9	15·2	14·8	16·1	..	17·2	15·0	16·5	14·8

Table LVIII. ULNA

	Tabūn I	*Bush-man*	*Nean-der-thal*	*Skhūl II*	*Skhūl IV*	*Skhūl V*	*Skhūl VII*		*Aus-tra-lian*	*Sikh*	*Chim-pan-zee*
	L	L	R	L	L	R	R	L	R	R	R
Semilunar cavity:											
height M 7 (1)	20·0	21·0	23·0	..	23·0	(25·0)	(22·0)	(25·0)	27·0	24·0	19·5
depth*	9·6	9·0	12·5	..	10·0	11·0	..	9·0	11·0	12·0	11·5
Olecranon:											
height (of cap) M 5	9·0	2·0	11·5	..	4·5	(4·5)	(6·0)	(6·0)	4·8	1·8	2·0
width M 6	21·0	21·0	28·0	..	27·5	(24·0)	(19·0)	(18·0)	22·0	25·0	18·0
depth M 7	25·0	20·0	27·0	..	24·0	(25·0)	24·0	(22·0)	24·5	27·0	26·0
Coronoid process:											
width†	17·0	20·0	26·0	19·0	25·0	(20·0)	(18·0)	(16·0)	20·0	27·0	21·0
depth‡	(27·5)	27·0	34·0	27·0	34·0	32·5	29·0	(28·0)	34·0	37·0	31·0

* Maximum depth of cavity measured at right angles to a plane tangent to the tips of the coronoid and the olecranon.
† Width from the mid-point of the upper border of the radial notch to the most distant point on the medial margin coronoid process.
‡ Projected dorso-volar diameter taken in the same manner as for the olecranon (M 7).

Table LIX. ULNA

	Tabūn I	*Bush-man*	*Nean-der-thal*	*Skhūl II*		*Skhūl IV*		*Skhūl V*	*Skhūl VII*	*Aus-tra-lian*	*Sikh*	*Chim-pan-zee*
	L	L	R	R	L	R	L	R	L	R	R	R
Curvature:												
length of chord M 4	185·0	188·0	195·0	..	..	229·0	220·0	213·0	191·0	223·0	225·0	225·0
subtense	7·0	4·0	(6·0)	..	..	5·5	3·5	9·0	10·0	3·0	6·5	13·0
index	3·8	2·1	(3·0)	..	..	2·4	1·6	3·8	5·2	1·3	2·9	5·8
Index of whole (sagittal) curvature* . .	8·5	8·1	(9·3)	..	..	7·6	7·2	9·3	11·8	7·5	8·5	11·4
Trochlear ridge-shaft angle†	3°	7°	0°	..	..	..	5·5°	13°	5°	13°	11°	10°
Incisura radialis:												
antero-post. diam.	12·0	11·0	(16·0)	15·0	14·5	16·0	15·0	13·0	14·0	15·0	19·0	12·0
vertical diam.	11·0	10·0	(12·0)	10·0	10·3	(10·0)	13·0	(10·0)	10·0	8·0	12·0	11·0
radio of vertical to antero-post. diam. .	91·6	90·9	75·0	66·6	71·0	62·5	86·6	76·9	71·5	53·3	63·1	91·6

* The chord is formed by the physiological length of the ulna; the subtense is the height of the arch formed by the flexor surface of the shaft when it rests on the coronoid and the head.
† Angle formed by the axis of the trochlear ridge of the semi-lunar cavity with the axis of the proximal third of the shaft of the ulna.

Table LX. ULNA

	Tabūn I		*Bushman*	*Neanderthal*	*Skhūl II*		*Skhūl IV*	
	R	L	L	R	R	L	R	L
Shaft diameters:								
Inteross. crest medio-lateral M 12	11·5	11·5	12·0	15·0	..	..	15·0	16·0
dorso-volar M 11 . . .	10·5	11·2	12·0	13·5	..	..	16·5	16·0
index	91·3	97·4	100·0	90·0	..	..	110·0	100·0
Upper Shaft:								
medio-lateral M 13	..	18·0	19·0	21·0	15·0	15·0	22·0	21·5
dorso-volar M 14	..	17·5	17·5	21·0	16·0	15·0	(21·0)	21·0
platolenic index	..	102·8	108·0	100·0	93·7	100·0	104·7	102·3
Pronator crest:*								
min. diam.	7·0	8·0	8·0	11·0	..	..	11·0	11·0
max. diam.	9·0	10·0	9·5	13·0	..	..	15·0	13·0
Max. width ulnar head . .	..	15·0	13·0	20·0	..	..	(19·5)	(18·0)

	Skhūl V		*Skhūl VI*	*Skhūl VII*		*Australian*	*Sikh*	*Chimpanzee*
	R	L	L	R	L	R	R	R
Shaft diameters:								
Inteross. crest medio-lateral M 12	15·0	16·0	(15·0)	(14·0)	13·0	15·0	17·0	15·0
dorso-volar M 11 . . .	15·0	14·5	(16·0)	(14·0)	12·0	12·3	15·0	14·0
index	100·0	90·6	..	100·0	92·3	82·0	88·2	93·3
Upper Shaft:								
medio-lateral M 13	22·0	..	(22·0)	17·0	(15·0)	17·0	24·0	15·0
dorso-volar M 14	23·0	..	23·0	17·5	16·2	25·0	27·0	20·0
platolenic index	95·6	..	95·6	97·1	92·5	68·2	88·8	75·0
Pronator crest:*								
min. diam.	11·0	10·5	..	..	7·0	8·6	11·0	10·0
max. diam.	14·0	13·5	..	..	11·0	11·0	12·0	11·5
Max. width ulnar head . .	..	..	..	(13·0)	15·0	15·0	16·5	18·0

* At the point of maximum development of the pronator crest in the distal part of the ulna.

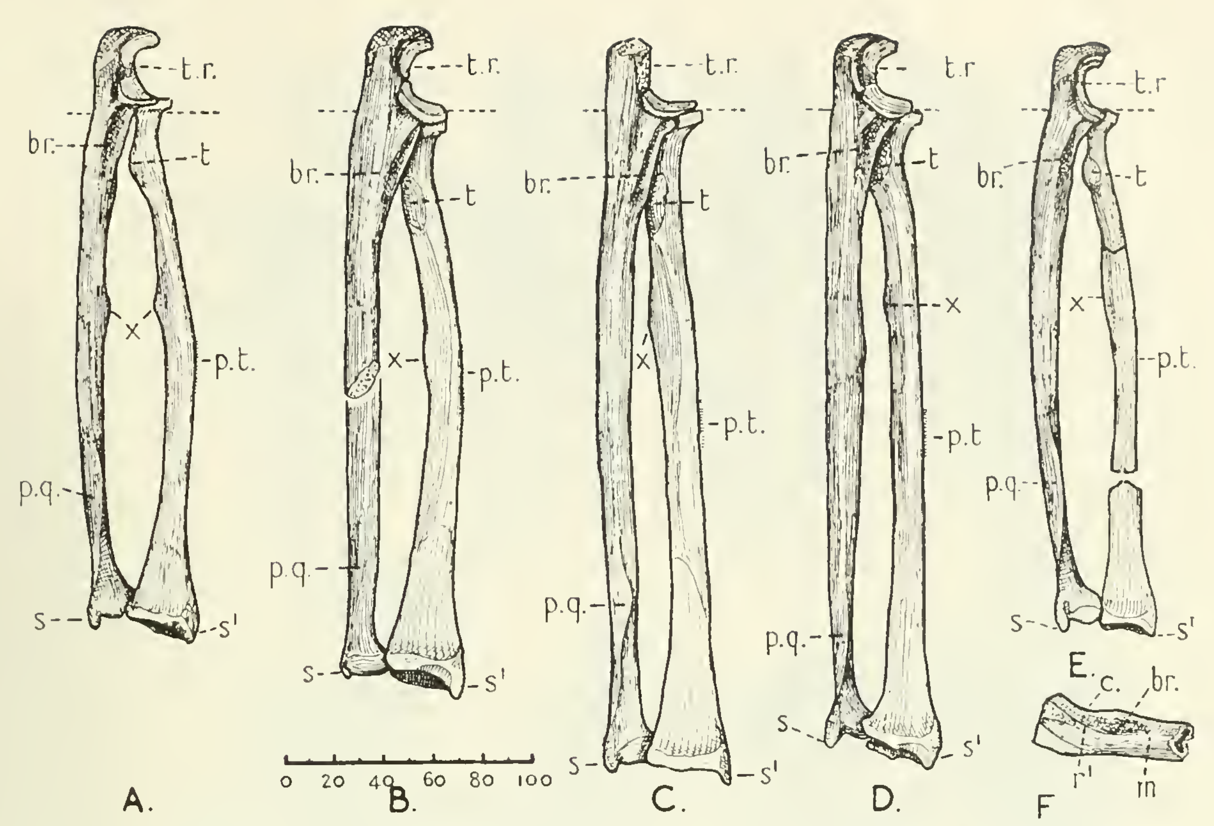


Fig. 110. The Radius and Ulna Articulated in the Semi-Prone Position and Drawn from the Ulnar Aspect at Right Angles to the Sagittal Plane. The ulna was placed so as to bring the trochlear ridge of the sigmoid cavity into the vertical sagittal plane, while the lower borders of the proximal and distal extremities are in the same horizontal plane. A, Tabūn I (left); B, Neanderthal (right, reversed, with details of the distal part of the ulna supplied from the left bone); C, Skhūl IV (right, reversed); D, Australian (left); E, Skhūl VII (left, with the distal end of the right radius, reversed); F, Skhūl II (right, reversed). *t*, tuberosity of the radius; *t.r.*, trochlear ridge; *br.*, brachialis insertion; *x*, interosseous crest; *p.t.* pronator teres insertion; *p.q.*, pronator quadratus ridge; *s*, styloid of ulna; *s'*, styloid of radius; *r*, coronoid ridge; *r'*, medial coronoid ridge.

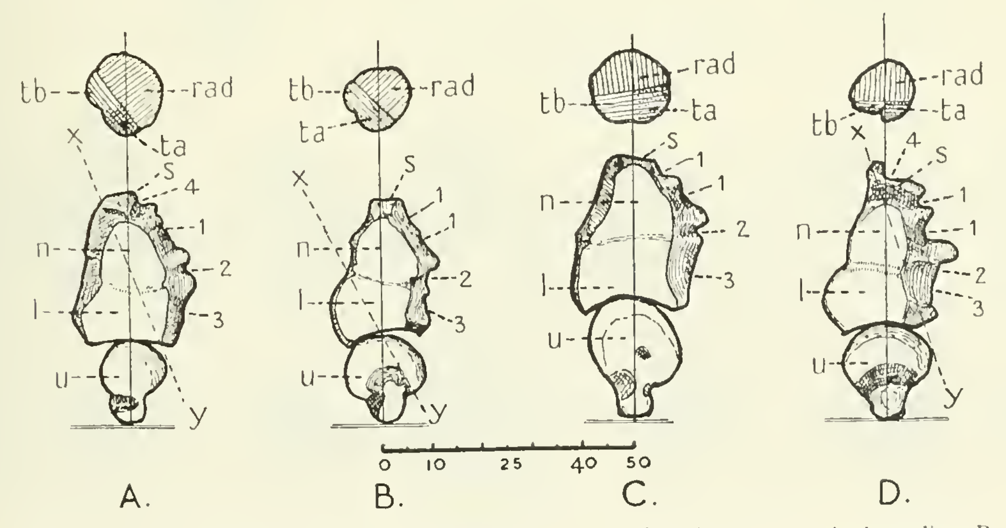


Fig. 111. Carpal Aspect of the Left Radius and Ulna in Semi-Pronation. A, Australian; B, Tabūn I; C, Neanderthal; D, Chimpanzee. Above each diagram is shown a cross-section of the radius (*rad*) at the level of the tuberosity. *x*–*y* represents the plane of the greatest curvature (in the Neanderthal radius this corresponds with the axis of the radio-carpal joint). *rad*, transverse sections of radius; *ta*, insertion of biceps on tuberosity; *tb*, bursal area; *n*, articular ara for navicular; *l*, articular area for semilunar; *s*, styloid of radius; 1, radial extensors of the carpus; 2, extensor pollicis longus; 3, extensor digitorum communis; 4, abductor pollicis longus; *u*, distal head of ulna,

Fig. 112. For description see below Fig. 114.

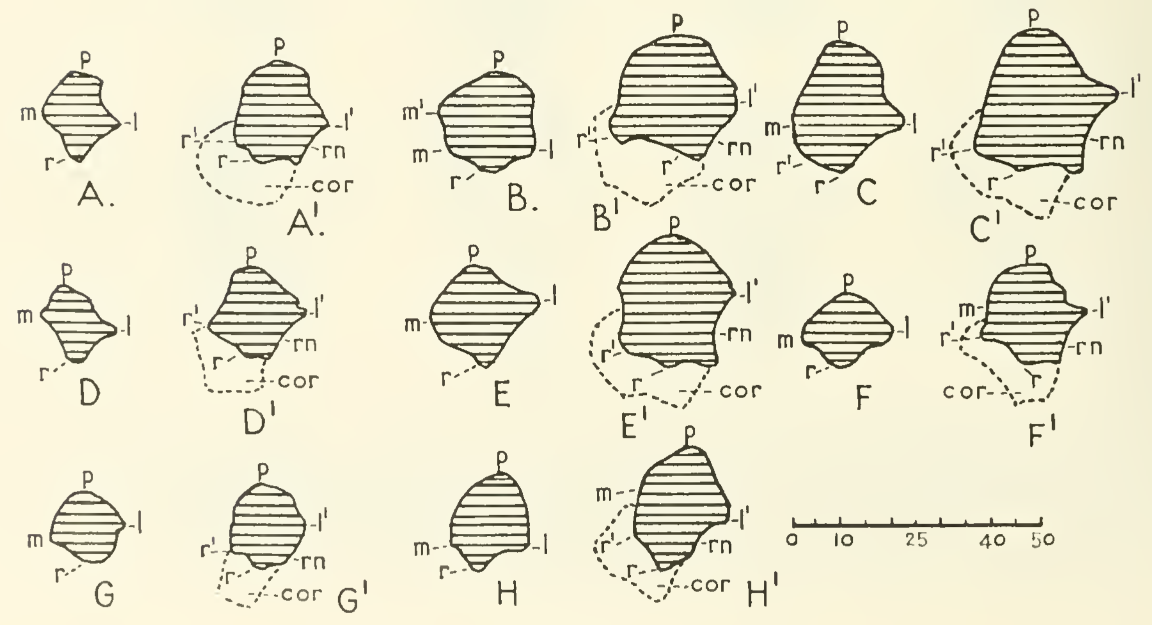


Fig. 113. For description see below Fig. 114.

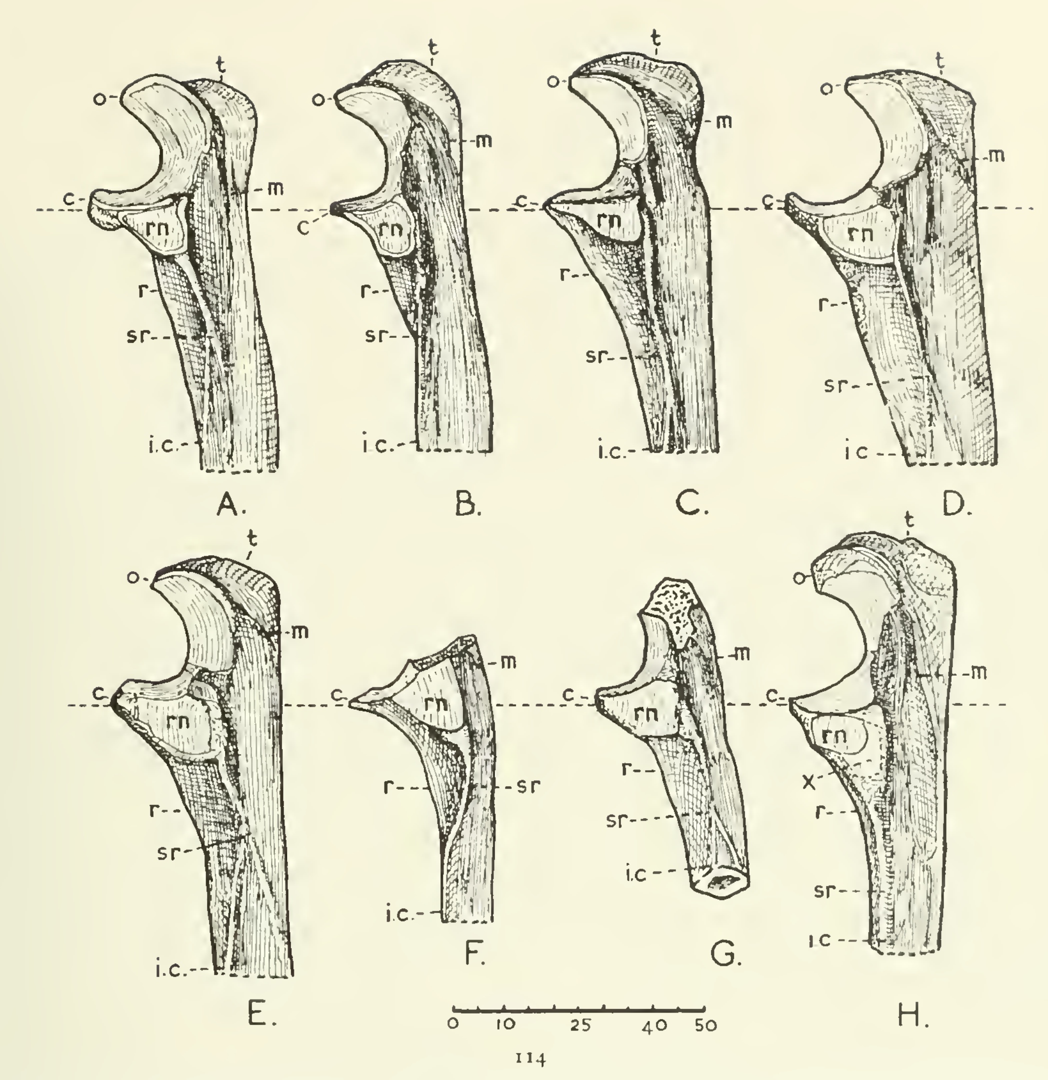


Fig. 112. Medial Aspect of the Proximal End of the Left Ulna. The bones are drawn at right angles to the sagittal plane represented by the trochlear ridge of the semilunar cavity. A, Chimpanzee; B, Tabūn I; C, Australian; D, Sikh; E, Skhūl IV; F, Skhūl VII (right reversed); G, Skhūl II; H, Neanderthal (right reversed). *x*, medial tuberosity of the olecranon; *o*, tip of the olecranon; *c*, tip of the coronoid process; *r*, principal coronoid ridge; *r′*, medial coronoid ridge; *br.*, area of tendinous insertion of brachialis muscle; *i.c.*, interosseous crest; *p*, intersigmoid area; *z*, defective area.

Fig. 113. Cross-Sections of the Coronoid Region of the Left Ulna. The left figure in each group was made at a level 10 mm. distal to the inferior margin of the radial notch, the right hand figure at a level 5 mm. distal to the anterior free margin of the coronoid process (represented by a broken line). A, A′, Chimpanzee; B, B′, Neanderthal, C, C′, Sikh; D, D′, Tabūn I; E, E′, Skhūl IV; F, F′, Bushman; G, G′, Skhūl VII; H, H′, Australian. *p*, dorsal border; *m*, medial border; *l*, 'supinator' ridge; *l′*, infralunate part of supinator ridge; *r*, principal coronoid ridge; *r′*, medial coronoid ridge; *rn*, radial notch; *cor*, outline of free margin of coronoid process.

Fig. 114. Lateral Aspect of the Proximal End of the Left Ulna. Shown on the same orientation as in Fig. 112. A, Chimpanzee; B, Tabūn I; C, Australian; D, Sikh; E, Skhūl IV; F, Skhūl VII (right reversed); G, Skhul II; H, Neanderthal (right, reversed). *o*, tip of the olecranon; *c*, tip of the coronoid process; *t*, tricipital area of olecranon; *rn*, radial notch; *r*, principal coronoid ridge; *sr*, 'supinator' ridge; *i.c.*, interosseous crest; *m*, anconeal margin; *x*, defective area.



CHAPTER XII

THE ARM (HUMERUS)

(Pl. XIII; Figs. 115–19)

THE humerus is represented by specimens from the following individuals:

Tabūn I. Left, complete; right, distal end missing (Figs. 115, 116 and Pl. XIII A, B, C).

Skhūl II. The extremities are missing from the right bone, the shaft being represented by a piece 215 mm. long. The humeral length is estimated to have been 330 mm., giving an estimated stature[1] of *c.* 1,625 mm. (5 ft. 4 in.–5 ft. 5 in.). The characters are slender and feminine (Fig. 117 A, F; B, F). The left bone is represented by a fragment of the distal part of the shaft, 130 mm. long.

Skhūl IV. This tall man is represented by the almost complete left humerus, 337 mm. long, giving an estimated stature of 1,681·6 mm. The bone was decayed and broken at the site of the insertion of the pectoralis major (Figs. 115, 116 C), but this has been successfully repaired. The right bone is represented by the distal end and the greater part of the shaft, measuring 279 mm. The proximal end is missing. See Pl. XIII, A, B, C.

Skhūl V. Both humeri are preserved in their entire length but their proximal ends have been crushed. The right bone has a total length of 380 mm., giving a stature of 1,806 mm. For their length, these bones are very slender (Figs. 115, 116, 117).

Skhūl VI. Male. There are two fragments of the right humerus, a piece of the distal end and a segment from the middle part of the shaft (44 mm.).

Skhūl VII. Female. The humeri are represented by middle and distal parts of the shafts of both bones down to the upper margin of the olecranon fossa. The two shaft fragments of the left bone measure 194 mm. together, and the least circumference is 48 mm. (Table LXI, p. 186). There is about half of the left trochlea, which has a sagittal diameter of 21 mm. (Table LXIII, p. 187.) The shaft fragment of the right humerus measures 160 mm. and has a least circumference of about 51 mm. As will be seen from the sections (Fig. 117 A, G) the bones were slender. There is also part of the trochlea adherent to the olecranon of the right ulna. We estimate the length to have been about the same as in the humerus of the Tabūn woman (*c.* 290 mm.).

Skhūl 12. Fragment of the proximal part of a right humerus, 82 mm. long. Its characters are male. It is not so heavily mineralized as most of the Skhūl fragments.

Skhūl 13. Fragment of the distal part of the shaft of a right humerus, 83 mm., probably male. The surface of the fragment bears the tooth marks of a small rodent and of a carnivore.

Skhūl 14. Splinter from the shaft of a left humerus, adult.

Skhūl 15. Distal part of the shaft of a right humerus, female. Length of fragment, 133 mm. The estimated original length of the bone was *c.* 270 mm.; stature 1,458 mm. (4 ft. 9 in.).

We have a humeral representation of perhaps 10 individuals—5 males, 4 females, 1 doubtful; but of these only three are approximately complete, namely, Tabūn I and

[1] Pearson's formulae.

Skhūl IV and V. For purposes of comparison we have used the casts of the right (complete) and left (incomplete) humeri of the Neanderthal skeleton, the humeri of a Sikh, an Australian (male), a Bushman (male), and a chimpanzee. We have noted measurements of the Neanderthal humerus made by Boule, Hrdlička, Klaatsch, Kramberger, and Fraipont.

SKHŪL TYPE OF HUMERUS

The humerus of the Palestinians differs altogether in type from that of the western European Neanderthalians. Like all the other long bones of the limbs, the Palestinian and Neanderthal humeri are of opposite types. The Skhūl humeri are long and relatively slender, in this being modern in type, whereas the Neanderthal men of western Europe had short, thick, stout bones.

In Table LXI (p. 186) are given the main measurements relating to the length and stoutness of the humerus. The right humerus of the man known as Skhūl V had a length of 380 mm. The tallest Cromagnon man reported by Verneau (Barma Grande 1) had a humerus of approximately the same length, namely, 379 mm. If we use Pearson's formulae (Martin, 1928, vol. ii, pp. 1070–1) for obtaining an estimate of stature from the humeral length, we are given a high stature for Skhūl V, 1,806 mm. This is 19 mm. more than was given by the comparable formula applied to his femur. The explanation will be seen in Table LXI, line 2, where the ratio of length of humerus to length of femur is given. In Skhūl V the humeral length is 73·3 per cent. of the length of femur. In the Neanderthal type of Europe the humerus is relatively shorter, forming 69–70 per cent. of the length of femur. The ratio was 71·2 per cent. in the Neanderthal skeleton. In the Tabūn woman the humerus was relatively very short, being 68·9 per cent. of her femur, a Neanderthal character. Yet, as will be seen from Table LXI, one must not attach any great racial significance to this ratio; in a Bushman it was 68·4, in an Australian 72, in Skhūl IV 68·2. The stature of the Tabūn woman, as indicated by the humeral length, was 1,505 mm. (just under five feet); that of Skhūl IV, 1,682 mm. (5 ft. 6 in.); that of Skhūl II, 1,625 mm. (5 ft. 4 in.); that of Skhūl VII, 1,513 mm. (4 ft. 11·5 in.).

Index of Robusticity.

This index is given in Table LXI (p. 186). It is an easy way of giving expression to the thickness or stoutness of a long bone, such as the humerus. The Neanderthals of Europe had a short and thick humerus, the index for the humerus of the Neanderthal skeleton being 22·2. The index for Skhūl V is much less, 15·9 for the left humerus, 16·8 for the right humerus—clear evidence also that this man was right-handed. In Skhūl IV the index rises to 18·9 for the right and 17·5 for the left, equal to amounts common in the humeri of modern races. The Australian used for comparison had an index of 18·6, a Bushman, 18·3, a Sikh, 18·1, a chimpanzee, 21. In the Tabūn woman it was 18·3 (right and left humeri had an equal circumference of 52·5 mm.), but in the other women the index was much lower. For example, Skhūl II had a least circumference of 51 mm. (right), and estimated length of 330 mm. giving an index of robusticity of only 15·4. The index in Skhūl 15 was probably equally low. The least circumference is only 50 mm. The least circumference in Skhūl VII is 51 mm. (right), the estimated original

length 290 mm., the index of robusticity, 17·5. Many of the humeral fragments at Krapina indicate the existence of small women with slender bones; this was also the case amongst the ancient Palestinians.

The widths of the head or proximal end of the humerus are given in Table LXI, line 5 (p. 186). The width in the Neanderthal humerus (measured on a cast of the bone) is 53 mm., which represents 16 per cent. of the length of the bone. Unfortunately the proximal ends of Skhūl IV and V are damaged, but in Skhūl IV the width was not more than 50 mm., giving an index of 14·5. The actual width in Skhūl V was perhaps 55 mm., slightly greater than in the Neanderthal humerus, but the length of the Palestinian specimen is 66 mm. greater, the indices being 14·4 on the right, 13·2 on the left. A characteristic of the Neanderthal long bones is the massiveness of the extremities as compared with modern bones. In this feature the Skhūl humeri are modern. Even in the Tabūn woman, who had so many Neanderthal points preserved in her anatomy, this feature is modern, the ratio being 14·7. The ratio is 13·4 in the Australian humerus, in the Bushman, 14, in the chimpanzee, 14·4.

Articular Head.

The measurements of the articular head are given in Table LXI (p. 186). This articulation is remarkable for its ample dimensions in the European Neanderthals, and for the fact that the transverse diameter exceeds the vertical, unlike the usual condition in modern humeri. The functional significance is by no means clear. This preponderance of the transverse diameter holds for the gorilla and the chimpanzee. In the Tabūn woman—both humeral heads being intact—the right has the Neanderthal form, the transverse diameter being 105·6 per cent. of the vertical. The left head is modern in form, the transverse being 97·3 per cent. of the vertical diameter. The Neanderthal proportions hold for the left humerus of Skhūl IV. The humeral heads of Skhūl V are crushed, so that it is not possible to say definitely what the transverse diameter was, but we believe that the Neanderthal form prevailed. The transverse diameter, as will be seen from Table LXI, varied from 91·8 to 97·5 per cent. of the vertical in the modern bones compared; it rose to 104·3 per cent. in a chimpanzee.

The circumferences of the articular head, given in Table LXI (p. 186), support the inferences we have drawn from other measurements, namely that the articular surface of the humeral head of the European Neanderthalian is relatively and absolutely great. The Palestinian humeri are of the modern type in this respect. The ratio of circumference of head to total length of bone is 47·7 per cent. in the Neanderthal humerus, 40·4 per cent. in Tabūn I, 38·8 per cent. in the Australian, 46·4 per cent. in a Bushman, and only 37 per cent. in a chimpanzee.

By examining the drawings given in Fig. 115, the reader will gather the chief points of resemblance and difference which are to be seen when front views of the Palestinian humeri are compared with Neanderthal and modern bones. The plane on which the bones are orientated is described in the explanation appended to Fig. 115. The left humerus of the Tabūn woman is placed between that of a Bushman (A) and the man, Skhūl IV (C), in Fig. 115. There is a general agreement in conformation and anatomical details. It will be noted that the Tabūn humerus, although only slighter longer than the Bushman, has more massive extremities, in this feature showing some degree of

resemblance to the Neanderthal humerus (Fig. 115 D). The articular head of the Tabūn bones is placed more directly on the extremity of the shaft, looks more upwards than in (B), or (C) (Fig. 115). The great tuberosity is pushed outwards so that it becomes prominent laterally, another point in which the Tabūn bone manifests Neanderthal characters. The medial epicondyle of Tabūn I, as viewed from the front, has not the massiveness seen in the Neanderthal humerus and yet we shall find, when it is viewed from the side (Fig. 116 A), that there is a striking resemblance, one not seen in the Skhūl or in modern bones.

The Tabūn humerus, viewed from the front, is remarkably straight, in this respect being like the Neanderthal humerus (Fig. 115 D), whereas in all the other bones brought here into comparison there is a bending outwards where the proximal meets the distal half of the shaft. We may speak of it as the deltoid curvature, as the apex of this curvature lies just distal to the deltoid impression. It is well seen in the Bushman and the Skhūl humeri, particularly that of Skhūl V (Fig. 115 E). Boule noted the deltoid curvature in the La Ferrassie humeri, so that no great racial significance can be attached to it.

The contrast between the Neanderthal and the Skhūl types is well brought out in Fig. 115 D, E. Indeed the resemblances between the Australian humerus (F) and the Neanderthal (D) are more numerous than those which link the Skhūl type to the Neanderthal. The relative slenderness of the Skhūl type will be appreciated although the large extremities of the humerus of Skhūl IV must also be noted in judging the racial affinities of the Palestinians.

Another view of these six humeri is given in Fig. 116. It is made at right angles to those in Fig. 115, representing profiles of the bones seen on their inner or medial aspects. One notices at once the great curvature in the Tabūn humerus which this view presents. The whole shaft is bent with its convexity on the extensor surface. One may measure the convexity, as in the case of the clavicle and the femur, by drawing a line along the base of the convexity, as shown by *x–y*, Fig. 116 A. The height of the convexity is 5 mm. The same curvature is seen in the Bushman humerus (Fig. 116 B), but it is chiefly confined to the distal half of the shaft and is only 3 mm. in height. In the humerus of Skhūl IV (Fig. 115 C) the extensor curvature is still more distal in position, as it is also in the humerus of Skhūl V (Fig. 116 E). This is also the case in the Australian humerus (Fig. 116 F); here the curvature is seen to be distal to the deltoid impression. The curvature in the Neanderthal humerus (Fig. 116 D) is also slight, being only 2·5 mm. in height, but it is evenly distributed throughout the length of the shaft as it is in the Tabūn humerus.

It will be noted that the articular head of the Tabūn humerus when viewed on its medial aspect (Fig. 116 A) is directed upwards more than is usual, while the trochlear projection (Fig. 115 A, *g*) is mainly in a forward direction. In the Bushman and Skhūl IV bones with which the Tabūn humerus is compared in Fig. 116 the articular head is directed upwards to a less degree, while the trochlear projection continues more in the axis of the shaft. When we turn to Fig. 116 D, E, F, however, we find that while these features are present in the Australian, as in the Bushman, yet in the Neanderthal specimen and in the humerus of Skhūl V they are as in the Tabūn specimen. The Skhūl specimen (IV) shares certain features with the modern type, while Skhūl V favours the Neanderthal form. We meet here among our ancient Palestinians, as so often before,

characters which seem to be intermediate or transitional between modern and Neanderthal types.

To save description and to give precise information of the characters of the Palestinian humeri, we give a series of sections of the shaft in Fig. 117. The points at which these sections were made are shown in Fig. 116 D. The outlines shown in Fig. 117 A, upper series, were made at the point of least circumference (*t*) and are representative of the distal half of the shaft. The triangular shape of the Australian section (Fig. 117 A, upper series A) may be taken as representative of modern humeri and is in striking contrast to the rounded Neanderthal outline (Fig. 117 A, upper series B).

The shafts of Skhūl IV and V are also rounded or Neanderthaloid in section. In the Tabūn specimen (Fig. 117 A, upper series E) we see a condition which may be described as intermediate between the rounded and the triangular form. Then in Fig. 117 A, upper series F (a Skhūl woman), we see the triangular form coming out in a slender and long bone; other Skhūl forms are seen in Fig. 117 A, upper series G, H. Thus we find transitional types in the shape of the shaft of the humerus, transitional from the rounded Neanderthaloid to the triangular modern type; transitional, too, from a robust masculine to a slender feminine form. These intermediate forms also occur among the Krapina people, and the La Ferrassie humeri also show some of these transitional features.

Sections made at the mid-point (*s*) of five of the six humeri (Figs. 115, 116) are reproduced in Fig. 117 B, middle series. Here again we meet two types, the rounded or Neanderthaloid, and the medio-laterally flattened, or Australoid. The rounded form is seen in the sections of the Neanderthal, Skhūl V, and Skhūl IV humeri (Fig. 117 B, middle series A, B, C). The Australian and Skhūl II (Fig. 117 B, middle series D, F) show the flattened form, while an intermediate type appears in the Tabūn section (Fig. 117 B, middle series E). Again we meet transitional forms between the Neanderthal and the modern type in the Palestinian humerus.

Sections made at the junction of the proximal fifth with the distal four-fifths of the shaft (Fig. 116 D, *r*) are shown in Fig. 117 C, lower series. The sections carry anteriorly the elevation of the pectoral ridge (*a*) which has a subdivided form in the Neanderthal humerus. There is a close resemblance in all four sections—the Australian (the narrowest), the Neanderthal, Skhūl IV, and Tabūn I. Yet the Palestinian forms are nearer to the Australian, or modern type, than to the Neanderthal.

We give measurements in Table LXII (p. 187) to amplify the information provided by sections of the shaft of the humerus depicted in Fig. 117. The measurements are made at two of the points shown in Fig. 116 D, namely at the distal end of the proximal fifth (level 'r'); and at the proximal end of the distal fifth (level 'v'). We find that the measurements made at these three points fall into three main groups: there are (1) those in which the dorso-ventral diameter greatly exceeds the medio-lateral (transverse) diameter, which we distinguish as stenobrachic; (2) those in which the transverse greatly exceeds the dorso-ventral diameter, the flat wide or eurybrachic type; and (3) those in which the diameters are approximately equal. If the dorso-ventral diameter is 90 per cent. or more of the transverse diameter but is less than 110 per cent., then we apply the term mesobrachic; if less than 90 per cent., stenobrachic, and if 110 per cent. or more, eurybrachic. If the ratios for the measurements of the upper shaft diameters are examined

(Table LXII, line 3, p. 187), it will be seen that all of the humeri fall into the mesobrachic group with one exception, the right humerus of Skhūl V, and as the proximal end of this bone has been compressed, it is probable that it was no exception to the above condition in its original form.

The diameters of the shaft at its mid-point ('s'), given in Table LXII, lines 4, 5 (p. 187), are the maximum and minimum ones without regard for orientation of the bone. The least diameter tends to be in a medio-lateral, the greatest in a dorso-ventral direction. The variability of the indices is high but the two Skhūl women (Nos. 11 and 15) have narrow bones, while in the Skhūl males, IV, V, and VI (2·2 × 19·5 mm.; index 88·6) the tendency is for the diameters to be more nearly equal.

We did measure, however, the sagittal and transverse diameters of the shaft at its mid-point and all are stenobrachic, with the exception of the right humerus of Skhūl IV. Tabūn I, Skhūl IV (left), Skhūl V, the Bushman, and the chimpanzee are high up in the stenobrachic group, 80 per cent. or upwards. In a lower group, lower in the scale of stenobrachia, are the Neanderthal humerus, Skhūl II, Skhūl VII, and the Sikh; they fall between the 70 and 80 ratios. Still lower in the scale, below 70, are the Australian (63) and Skhūl 15 (68·5). The Skhūl type covers a wide range of values at this level of the humerus, from 68·5 to 91·3. It is to be noted that the Neanderthal humerus occupies a position near the middle of this range.

The lower shaft ratios (Table LXII, line 9, p. 187) are, without exception, eurybrachic. The highest figures of eurybrachia are amongst the Skhūl specimens: Skhūl 15 (169·2), Skhūl IV (164). The Neanderthal bone is lowest in the scale (111·3). The chimpanzee humerus at this point shows a high degree of eurybrachia. More important than the ratios are the absolute measurements of the shaft diameters. The Neanderthal humerus in this respect exceeds all the others, in spite of its short shaft. As we have seen from the index of robusticity (pp. 180–1) the Skhūl bones are essentially slender in form.

Characters of the Distal Extremity.

The massiveness of the articular ends of the long bones is a character of the European Neanderthalians. As will be seen from Table LXIII (p. 187), the epicondylar width of the Neanderthal humerus is 65 mm. The left humeri of Skhūl IV and Skhūl V have the same width; the right of Skhūl IV is somewhat wider, 68 mm. In the most massive Cromagnon male, Barma Grande No. 1, the epicondylar widths were 68 and 70 mm. When we take into consideration the total length of the humerus, however, the Skhūl humeri have the proportions which prevail in modern humeri, and the ratios are lower than is the case in the Neanderthal humerus, where the epicondylar width is equal to 20·7 per cent. of the length. The ratios amongst the Palestinian humeri vary from 17·1 to 20·1, almost the same as in the modern bones given for comparison in Table LXIII.

We measured the proportion which the medial epicondyle formed to the total width, taking the medial margin of the trochlea as a basis for estimating the width of the epicondyle. The highest measurement, 17 mm., is reached in the Tabūn humerus; it is 16 mm. in Neanderthal, 15 mm. in Skhūl IV and the Australian, 14 mm. in the Sikh, and 13 mm. in Skhūl V, the Bushman, and the chimpanzee. As will be seen from Fig. 118 F, the medial epicondyle is thickest in the Neanderthal humerus. The base (vertical diameter) is sharply defined but this is less apparent in all the other specimens represented in

Figs. 115, 116. There is one peculiar feature of the medial epicondyle brought out in the drawing given in Fig. 118. Among the humeri shown, there are three in which the epicondyle bends definitely backwards (downwards); these are the Neanderthal Skhūl V and the Tabūn specimens. In the other three, including the modern and the Skhūl bones, the condyle continues in the transverse plane of the terminal end.

It will also be noted that behind the capitulum there is a massive accumulation of bone in the Neanderthal humerus (Fig. 118 F, *g*). This post-capitular mass is also large in Skhūl V, the Australian, and to a lesser extent in Skhūl IV. It is slight in the Bushman and very slight in Tabūn I, leaving the lateral border of the trochlea exposed, but in the humeri of Neanderthal, Skhūl V, and the Australian the lateral border is deeply buried in the mass. The posterior surface of the trochlea forms a wide, shallow arch in Skhūl V and in the Neanderthal specimens. We have here a series in which the Palestinian bones share features with modern bones on the one hand and with the Neanderthal type on the other.

In Table LXIII, lines 3, 4, 5 (p. 187), we give the transverse width of the articular end, its antero-posterior diameter, represented by the medial margin of the trochlea, and the ratio which the latter holds to the former. The only pertinent fact which emerges is that the dimensions of the articular diameters of the Neanderthal bone exceed those of all the others.

There is one feature of the Neanderthal type of humerus on which all observers agree: the olecranon fossa is relatively and absolutely large. In Table LXIII, lines 9, 10 (p. 187), we give the transverse and vertical diameters of this fossa; only one of our specimens shows this Neanderthaloid feature, that of the Tabūn woman. The Skhūl humeri, particularly when we take their great length and width into consideration, have relatively small fossae, in this agreeing with the humeri of modern races. We also sought to determine the depth of the fossa, a difficult matter because of the sloping margin. The depth varied from 6 to 10 mm., the deepest fossa being those of Tabūn I and Skhūl V.

The cubital angle, the angle formed by the plane of the inferior trochlear margins with the axis of the bone, is given in Table LXIII, line 6 (p. 187). This angle varies from 86° in the Tabūn humerus to 77° in that of a chimpanzee. The angles are smallest in modern bones; they are low in the Palestinian bones and the Tabūn specimen is near the figure for the La Chapelle humerus (87°).

Characters of the Proximal End.

In Table LXIII, line 7 (p. 187), we give the angle at which the head is set to the transverse plane of the elbow point, as represented by the distal articular end. We determined this angle of torsion of the humerus by the method recommended by Martin. The angle varied from 135° in the humerus of a chimpanzee to 156° in the humerus of a Bushman. In the Neanderthal humerus it is 152°, the same as in an Australian specimen; in Tabūn I it is 148°, the same as in La Chapelle, and in Skhūl V it is 144°. The functional significance is not easy to interpret: it depends on the position of the scapula on the thorax and many other factors. As a criterion of race it has little, if any, value.

We also determined the angle which the vertical diameter of the base of the articular cap or head forms with the axis of the shaft. The results are given in Table LXIII, line 8 (p. 187). As may be seen from the drawing of the Tabūn humerus (Fig. 116 A),

the head of this bone looks 'upwards' to a greater degree than is usual. This is also apparent in Fig. 119 B, where a greater area of the articular head is seen than is usually the case. The angle which the articular base forms with the shaft is 54°. It is probably almost as great (53°) in the left humerus of Skhūl V (Fig. 119 F). In the Neanderthal humerus it is only 45°, in an Australian 35°, in a Sikh and in a chimpanzee humerus, 45°. As with the angle of torsion, we get no guide to race in this measurement. It is remarkably high in the three Palestinian humeri which were measurable.

Summary.

An examination of the Palestinian humeri and our comparisons have led us to the conclusion that in the majority of their characters the Skhūl bones agree more closely with those of modern races than with those of the Neanderthal type of Europe. The humerus of the Tabūn woman shows certain features which are definitely Neanderthaloid, and yet there are others in which it agrees with the Skhūl or with the modern type. Further, the only humeri of prehistoric man which approach the type shown by Skhūl IV and V are those of the tall Cromagnon men described by Verneau. They are, in spite of their dimensions, essentially slender in build, whereas the European Neanderthals had short, heavy bones. We have also evidence that amongst the Palestinians there were individuals who had small and slender humeri and were of short stature. In this the fossil people of Mount Carmel resemble the Neanderthal people of Krapina.

Table LXI. HUMERUS

	Tabūn I		*Skhūl IV*		*Skhūl V*		*Neanderthal*	*Sikh*	*Australian*	*Bushman*	*Chimpanzee*
	R	L	R	L	R	L	R	L	R	L	L
Maximum length M 1	(236·0)*	287·0	(279·0)*	337·0	380·0	379·0	314·0	330·0	335·0	278·0	276·0
Ratio: humeral to femoral length	..	68·9	..	68·2	73·3	73·1	71·2	73·4	72·0	68·4	103·3
Least circum. M 7	52·5	52·5	64·0	59·0	64·0	60·0	70·0	66·0	62·5	51·0	58·0
Index of robusticity	18·3	18·3	18·9	17·5	16·8	15·9	22·2	18·1	18·6	18·3	21·0
Width prox. end M 3	42·0	42·0	..	(50·0)	(55·0)	(50·0)	53·0	47·0	45·0	39·0	40·0
Ratio: width of head to length of bone	14·7	14·7	..	14·5	14·4	13·2	16·0	14·2	13·4	14·0	14·4
Articular head:											
vertical diameter M 10	35·0	38·0	..	45·0	(53·0)	(45·0)	48·0	45·0	42·0	37·0	35·0
transv. diameter M 9	37·0	37·0	..	50·0	..	..	49·0	42·0	41·0	34·0	36·5
index	105·6	97·3	..	111·1	..	..	102·0	93·3	97·5	91·8	104·3
circumference M 8	114·0	116·0	..	151·0	(165·0)	..	150·0	134·0	130·0	129·0	102·0

* Length of part preserved.

Table LXII. HUMERUS

	Tabūn I		*Skhūl II*		*Skhūl IV*		*Skhūl V*	
	R	L	R	L	R	L	R	L
Upper shaft diameters:								
medio-lateral	19·0	18·0	..	..	..	..	(24·0)	23·0
dorso-ventral	19·3	19·0	..	..	..	.	(28·0)	21·5
index	98·4	94·6	..	..	..	..	85·7	107·0
Mid-point of shaft diameters:								
greatest M 5	19·5	18·5	19·0	..	(23·0)	21·0	21·3	20·5
least M 6	14·6	14·5	12·7	..	(20·0)	17·0	18·0	17·5
index	74·8	78·9	66·8	..	87·0	80·9	84·5	85·3
Lower shaft diameters:								
medio-lateral	..	21·0	19·0	18·0	29·5	28·0	24·0	25·0
dorso-ventral	..	15·0	16·0	15·0	19·0	17·0	19·0	18·0
index	..	140·0	118·7	120·0	155·2	164·6	126·3	138·0

	Skhūl VII		*Skhūl 15*	*Neanderthal*	*Australian*	*Sikh*	*Bushman*	*Chimpanzee*
	R	L	R	R	R	L	R	L
Upper shaft diameters:								
medio-lateral	..	..	..	26·0	19·0	22·0	18·0	21·5
dorso-ventral	..	..	..	25·0	21·0	22·5	18·0	20·0
index	..	..	..	104·0	90·4	97·7	100·0	107·5
Mid-point of shaft diameters:								
greatest M 5	(18·5)	17·2	18·2	25·0	23·0	22·0	18·8	19·7
least M 6	(12·5)	13·5	12·5	19·5	15·0	17·0	15·8	17·1
index	67·5	78·4	68·4	78·0	65·2	77·2	81·3	86·7
Lower shaft diameters:								
medio-lateral	..	(21·0)	22·0	24·5	26·0	26·0	21·0	25·0
dorso-ventral	14·5	15·0	13·0	22·0	18·0	18·0	15·0	15·0
index	..	..	169·2	111·3	144·0	144·0	140·0	166·6

Table LXIII. HUMERUS

	Tabūn I	*Skhūl IV*		*Skhūl V*		*Neanderthal*	*Australian*	*Sikh*	*Bushman*	*Chimpanzee*
	L	R	L	R	L	R	R	L	R	L
Epicondylar width M 4	55·0	(68·0)	65·0	60·0	(65·0)	65·0	58·0	60·0	55·0	56·0
Epicon. width-length index	19·1	20·1	19·2	15·7	17·1	20·7	17·3	18·1	19·7	20·2
Width artic. surface M 12*a*	38·0	(53·0)	46·0	43·0	..	48·0	42·0	44·0	41·0	41·5
Sagittal diam. of trochlea M 13	21·0	(25·0)	27·0	26·0	25·0	29·0	24·5	27·0	22·0	26·0
Trochlear index	55·2	..	60·0	57·7	..	60·4	58·3	61·3	53·6	62·6
Angles:										
cubital M 16	86°	..	84°	83°	84°	83°	80°	78°	78°	77°
torsion M 18	148°	144°	..	144°	..	152°	152°	150°	156°	135°
axis of head to shaft M 17	54°	..	42°	..	(53°)	45°	35°	45°	31°	45°
Olecranon fossa:										
width M 14	27·0	..	31·0	26·0	27·0	29·0	27·0	23·0	25·0	21·0
vert. diam.*	16·0	..	16·0	16·0	14·0	18·0	16·0	15·0	16·0	13·0

* The maximum diameter, measured parallel to the axis of the shaft.



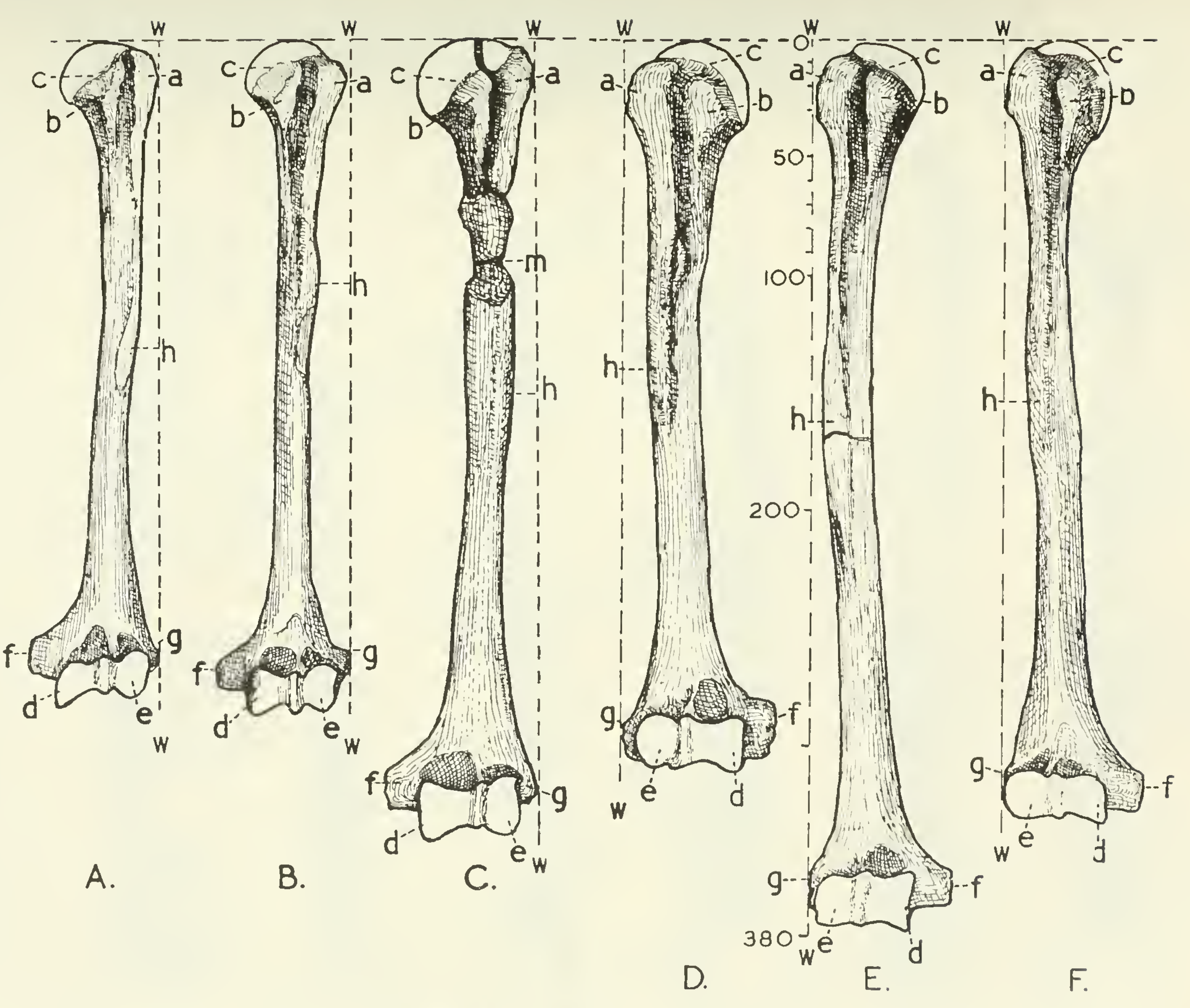


FIG. 115. ANTERIOR OR FLEXOR ASPECT OF THE HUMERUS. A, Bushman (left); B, Tabūn I (left); C, Skhūl IV (left); D, Neanderthal (right); E, Skhūl V (right); F, Australian (right). *a*, great tuberosity; *b*, lesser tuberosity; *c*, upper articular point of head; *d*, highest point of trochlea; *e*, highest point of capitulum; *f*, medial epicondyle; *g*, lateral epicondyle; *h*, deltoid impression; *m*, point of break in Skhūl IV. The plane on which the humeri were orientated for drawing was determined by placing each bone on the measuring board resting on its dorsal surface. Three points were then brought into the same horizontal plane (cf. Fig. 116, *P–P*) by means of small supports. These are the highest point on the articular head of the humerus (*c*); the highest point on the trochlear surface (*d*); the highest point on the capitulum (*e*). The lateral border of the great tuberosity (*a*) is brought into the same longitudinal plane (*W–W*) as the outermost point of the lateral epicondyle.

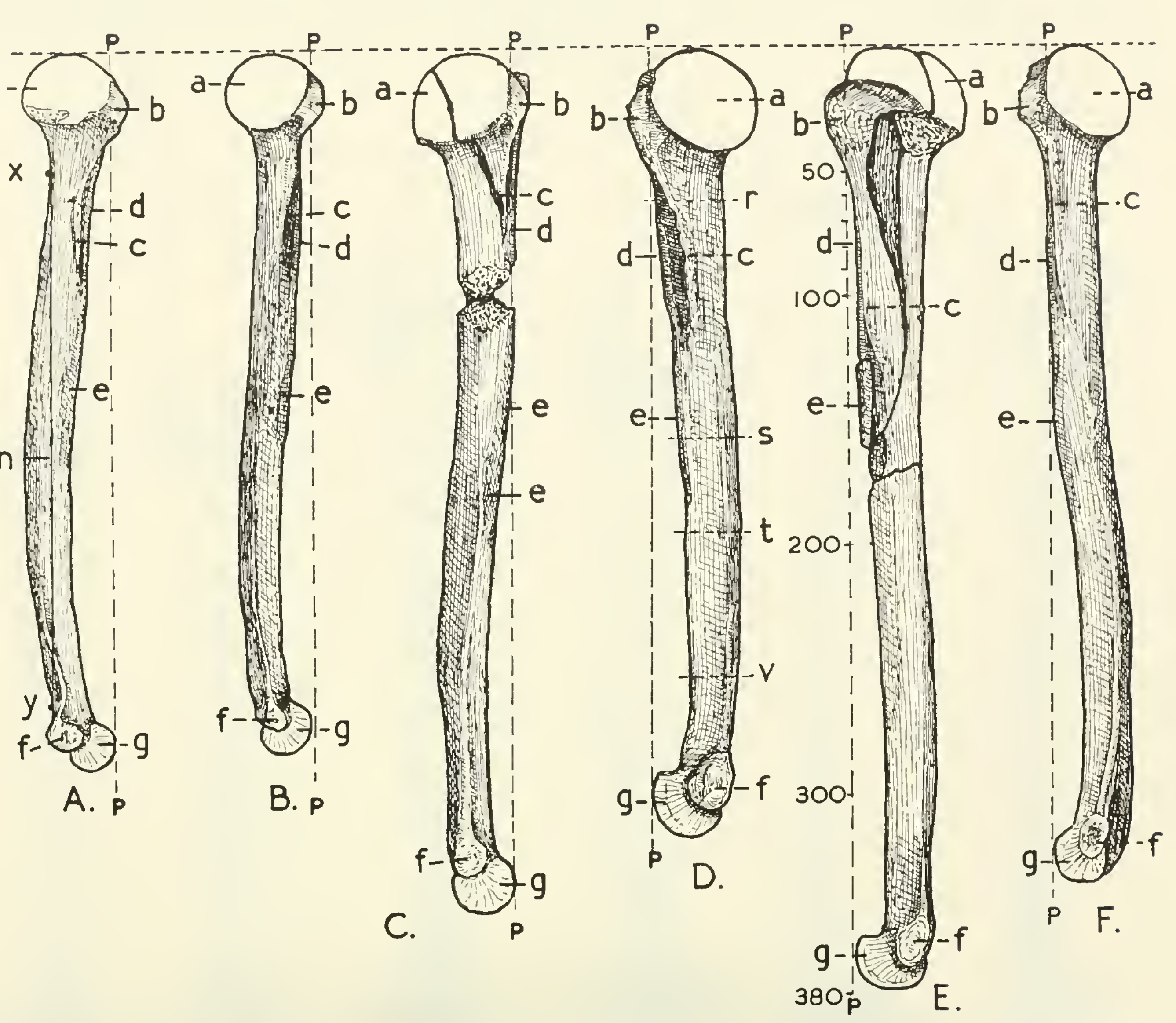


Fig. 116. Medial Aspect of the Humerus. A, Tabūn I (left); B, Bushman (left); C, Skhūl IV (left); D, Neanderthal (right); E, Skhūl V (right); F, Australian (right). *x–y*, basal ehord of the extensor eurvature of the shaft; *n*, end of the subtense (height) of the extensor eurvature; *a*, articular head; *b*, surface for insertion of subscapularis on lesser tuberosity; *c*, inner lip of bicipital groove; *d*, outer lip of bicipital groove (pectoral ridge); *e*, insertion for deltoid musele; *f*, medial epicondyle; *g*, trochlea; *r*, *s*, *t*, levels of transverse seetions (cf. Fig. 117); *v*, level of distal diameters, Table LXII. *P–P*, basal plane of orientation (cf. Fig. 115).

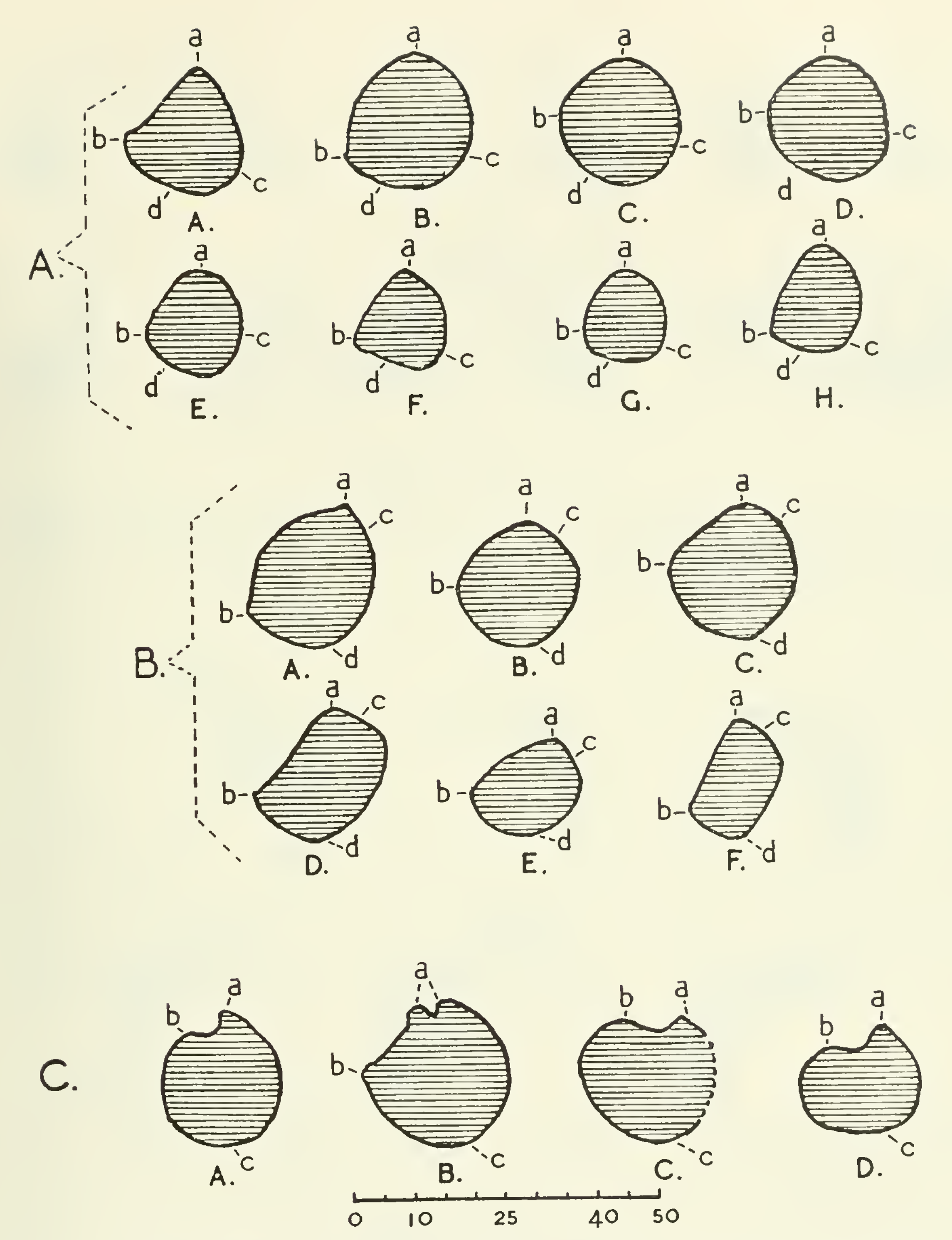


FIG. 117. TRANSVERSE SECTIONS OF THE SHAFT MADE AT THE LEVELS *r*, *s*, *t* IN FIG. 116 (viewed from above). A, upper series (least circumference; level '*t*'). A, Australian; B, Neanderthal (cast); C, Skhūl V; D, Skhūl IV; E, Tabūn I; F, Skhūl II; G, Skhūl VII; H, Skhūl *15*. *a*, anterior border; *b*, medial border; *c*, lateral border; *d*, extensor surface. B, middle series (midpoint of the shaft; level '*s*'). A, Neanderthal (cast); B, Skhūl V; C, Skhūl IV; D, Australian; E, Tabūn I; F, Skhūl II. *a*, anterior border; *b*, medial border; *c*, deltoid impression; *d*, extensor surface. C, lower series (junction of the proximal fifth with the distal four-fifths; level '*r*'). A, Australian male; B, Neanderthal; C, Skhūl V; D, Tabūn I. *a*, pectoral ridge; *b*, medial border of the bicipital groove; *c*, extensor aspect.

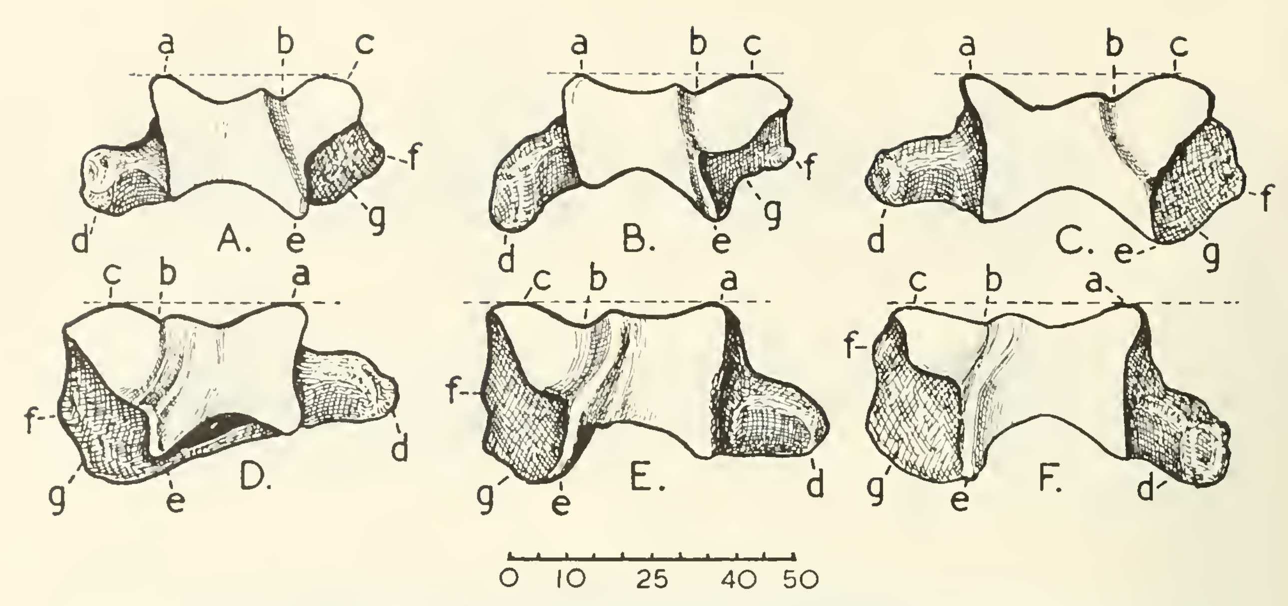


FIG. 118. THE DISTAL END OF THE HUMERUS. A, Bushman (left); B, Tabūn I (left); C, Skhūl IV (left); D, Australian (right); E, Neanderthal (right); F, Skhūl V (right). Drawings have been made at right angles to the plane *P–P* (cf. Figs. 115, 116). *a*, trochlea; *b*, groove between trochlea and capitulum; *c*, capitulum; *d*, medial epicondyle; *e*, hinder end of trochlear margin; *f*, lateral epicondyle; *g*, post-capitular mass.

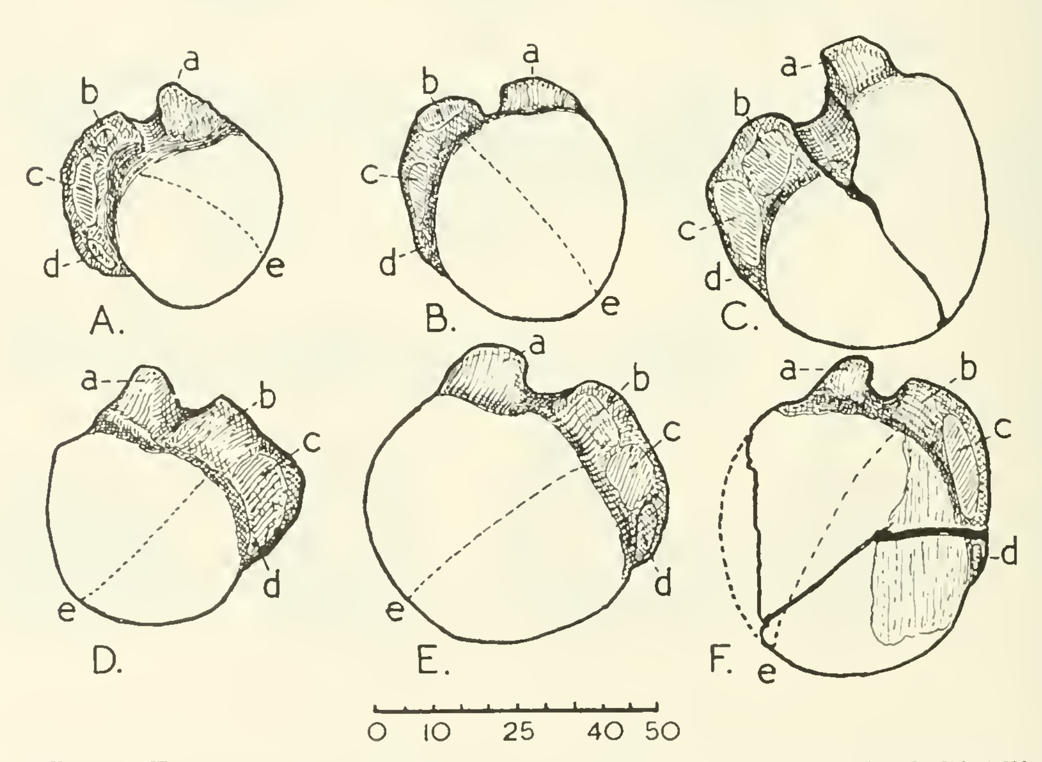


FIG. 119. THE PROXIMAL END OF THE HUMERUS. A, Bushman (left); B, Tabūn I (left); C, Skhūl IV (left); D, Australian (right); E, Neanderthal (right); F, Skhūl V (right). Drawings made at right angles to the plane *P–P* (cf. Figs. 115, 116). *a*, lesser tuberosity (exposing the surface into which the subscapularis is inserted); *b*, insertion of the supraspinatus on the great tuberosity; *c*, insertion of the infraspinatus; *d*, insertion of teres minor; *e*, vertical axis of the articular head.

CHAPTER XIII

THE DENTITION

(Pls. XIV, XXVI, XXVII; Figs. 120–42)

IT will be well to consider certain features which are believed to distinguish the teeth of Neanderthal man, especially those found at Krapina, before proceeding to describe the teeth of the ancient people of Mount Carmel. The dentitions of the Krapina Neanderthalians tend to show a triple series of changes (Kramberger, 1908; Adloff, 1907; Gregory, 1916, 1926; Remane, 1921): (1) The upper incisors and canine tend to assume a premolar character by producing an inner or lingual cusp, a change which we may speak of as 'premolarism'. The lower incisors and canine are also liable to show this change but to a much less extent. (2) The pulp cavity of the molar teeth tends to become enlarged and extends into the dental tissue which should go to the formation of the roots, a change which is usually spoken of as 'taurodontism'. (3) The enamel of the molar cusps tends to lose its regularity of form and to become broken up into complicated patterns, a change for which the name 'anomoplasia'[1] has been suggested—a kind of enamel anarchism. We may speak of a dentition which tends to assume all these three changes as 'Krapinoid'. Among the Mount Carmel teeth we find only one of these changes, the occurrence of premolarism or lingual cuspidization of the incisors. There is no real taurodontism in the Carmel molars and although the enamel patterns of the molars show peculiar features, these are not of the irregular nature found so frequently in the molar teeth of the Krapina people.

It is important that we should make a separate study of the teeth from the Tabūn cave. Our studies of the Tabūn woman have revealed many points in which she differs from the people found in the Skhūl cave, suggesting to us that we have to deal with two human types. While these types are related, they differ in that the Tabūn type possesses many Neanderthalian (Palaeoanthropic) features, while the Skhūl type manifests many modern or Neanthropic features. We shall describe, therefore, the Tabūn and the Skhūl teeth separately and having given our description will consider whether the teeth give support to the separation of the Tabūn from the Skhūl people.

THE TABŪN TEETH

The material at our disposal is the following:

(1) The upper and lower teeth of Tabūn I. The mandible carries a complete dentition, the cusp pattern being still distinguishable in Molars 2, 3, but M–1 has the dentine exposed at the bases of the cusps. The upper dentition is complete except for the right M–3 which is missing. The crowns of the right I–2 and left Pm–1 are broken away.

(2) The dentition of the large male mandible, Tabūn II. All the teeth are present save the left I–2. The enamel has been worn away and the dentine is exposed over the greater part of the chewing surface.

(3) A series (Series I) of unworn teeth from Layer B of the Tabūn cave. A part of the

[1] Suggested by Mr. Morley Roberts.

right maxilla was found with these teeth belonging to a child—probably a boy of about ten or eleven years of age (Fig. 120 A, B). The teeth are all of the upper right side, I–2, C, Pm–1, Pm–2, M–1, M–2. This unworn series provides us with excellent material for study (see Pl. XIV, 1).

(4) Another unworn series (Series II) from the Tabūn cave, consisting of an upper left I–2, lower right I–2, part of the crown of an upper right Pm–1, upper right M–1, part of the crown of an upper left M–1. All of the specimens except the lower right I–2 (Layer B) are from Chimney II (cf. Garrod and Bate, 1937).

(5) A miscellaneous series (Series III) showing various degrees of wear, consisting of an upper left I–2, slightly worn upper left I–1, lower left M–1; crown of a worn right lower M–3. All the specimens came from Layer B.

(6) A series of milk teeth (Series IV) comprising an upper right i–1, slightly worn (Chimney II); an upper right and a left m–2 much worn (Layer B); a lower left m–2 (Chimney II). The two upper molars come from the Layer B and may belong to Series I and to the specimen shown in Fig. 120.

(7) There is a series (Series V) of miscellaneous teeth from the Tabūn consisting of the upper m–2 (right), I–1 (right; incompletely formed), I–1 (left; unworn); canine (right; much worn); Pm–1 (right; slightly worn). The lower teeth are a canine (right; much worn), canine (left; slightly worn), M–1 (right; moderately worn), M–1 (right), M–2 (left; fragment). These were found in the superficial deposits of the Terrace of the cave and have an appearance of no great age. Their features are similar to the dental characters of modern peoples and we have not included them in our tables or in the present discussion.

(8) A single lower right M–1 or M–2. It is older than the other teeth, coming from Layer E*b* in the upper part of the Acheulean sequence of strata, and is also older than the fragment of femur shaft (Fig. 29) which came from Layer E*a*. This tooth will be described in detail, though unfortunately the occlusal surface is worn, the dentine at the bases of the cusps being exposed (cf. Fig. 129 C, D).

Milk Dentition

The measurements of the four Tabūn milk teeth are given in Table LXIV, Series IV, (p. 209). There is nothing characteristically Palaeoanthropic in their dimensions. We have compared them with the dimensions of the Krapina teeth and, while the upper i–1 is slightly larger than any of the corresponding incisors found at Krapina, those of the upper m–2 fall within the range of the corresponding Krapina teeth. The lower m–2 has a medio-distal diameter as great as the longest Krapina molar (11·2 mm.) but is somewhat narrower (9·4 mm. as against 10 mm.). The labio-lingual diameter forms only 84 per cent. of the length (m–d diameter) of the crown.

The characters of the upper median incisor will be seen in the drawing given in Fig. 121 A. The striking feature of the crown is the great development of the lingual heel, reminiscent of the condition seen in the chimpanzee (Fig. 121 E) and also to a less degree in the Australian (Fig. 121 D). We infer from Kramberger's description that in the form of its lingual heel the Carmel upper median incisor resembles the Krapina incisor, but here the root is oval in section, not prismatic as in the Krapina specimens, and shows no trace of a groove along the buccal aspect. As regards the upper second milk

molars, there is little to note. The three roots are widely spread, as in modern milk dentitions, all four cusps are well and almost equally developed. The enamel pattern is worn off in both specimens.

A drawing of the lingual aspect of a lower milk molar is given in Fig. 129 A. All five cusps are fully developed and a well marked anterior fovea is still evident but the rest of the enamel pattern has disappeared through use.

Permanent Teeth

Tabūn Series I–II.

Upper I–1. There is only one upper median incisor, shown in Fig. 121 C. Its dimensions are in no way remarkable, for among the Krapina and Australian median incisors similar dimensions are common. Its characteristic features lie in the development of the lingual heel, which tends to separate itself from the rest of the crown to form a separate cusp (Fig. 121 C, *lt*). The drawings in Fig. 121 (see also Figs. 136, 137) demonstrate the features of the crown. This tooth differs in the characters of its lingual tubercle from the Krapina pattern described by Kramberger, where the lingual tuberosity assumes a fold-like form, fashioned out of an over-developed cingulum. On the other hand, the condition seen in the upper median incisor of the Le Moustier youth is very similar to that seen in the Carmel incisors. It is true that a tendency to assume a bicuspid form is occasionally seen in modern races; it was apparently constant in the Neanderthalians of Europe, and in this respect the Tabūn people are Neanderthals. It is noteworthy that the corresponding milk tooth retains the more primitive form of lingual tuberosity.

Upper I–2. Adolf Remane is of the opinion that, of all the teeth, the upper lateral incisors are—so far as the Primates are concerned—the best indicators of race and species (Remane, 1921), and in this we are inclined to agree with him. There are three separate unworn lateral incisors from et-Tabūn. Two of these are depicted in Fig. 122 A, C. They possess features which are certainly Neanderthaloid. The outstanding feature is the cuspidation of the lingual heel of the crown. The lingual aspect of the crown is hollow, pronouncedly shovel-shaped, the side margins of the crown are folded inwards and a deep median furrow ascends the crown (Fig. 122 C). Only two examples of this tooth were found at Krapina and, while their measurements are smaller than those of Tabūn, their crowns, as may be seen from Fig. 122 B, were cuspidate with in-rolled sides. Of our three isolated examples, one is large (Series II), the other two are of smaller size yet larger than the Krapina specimens. The upper lateral incisors of the Le Moustier youth have the characters seen in the Mount Carmel specimens. In brief, the Tabūn upper lateral incisors show the peculiarities which are believed to characterize the Neanderthal group of humanity. We must not forget that hollowing and cuspidation do also occur in the upper lateral incisors of certain modern races, especially those of Mongolian stock.

Upper Canine. There is only one isolated unworn upper canine from et-Tabūn, that belonging to Series I. As will be seen from Fig. 123 B (also Pl. XIV, 1) the crown of this tooth shows a tendency to assume a bicuspid (premolar) character. The cingulum on the lingual heel is greatly developed, running upwards on the proximal margin of the crown. As in the premolar teeth, the cingulum on the distal side of the crown shows a definite talonid development. It is as if the bud for the upper canine had been 'infected' with a developmental influence which should have gone wholly to the premolars. The

same change is also to be seen in the Krapina (Fig. 123 C), the Le Moustier, and to some degree in the Bushman's canine (Fig. 123 A). In the Le Moustier canines there is a definitely differentiated lingual cusp. The Tabūn specimen is smaller than those found at Krapina.

Upper Pm–1, Pm–2. There are only three specimens in the Tabūn collection, all unworn, two of them from Series I. Their dimensions are small, less than is usual in Neanderthal dentitions. As may be seen in the drawings given in Fig. 124, and the photographs in Pl. XIV, 1, 6, the enamel pattern, although devoid of the fragmentation seen in the Krapina upper premolars, yet is especially complex in Pm–2. The buccal cusp is slightly higher than the lingual (Fig. 124 A), and forms a larger part of the occlusal surface than does the lingual (Fig. 124 A, B). Two ridges on the occlusal surface of Pm–1 proceed towards the centre of the crown from the lingual cusp. Each cusp sends a marginal ridge towards the other, those on the distal margin turning into the crown as they meet (Fig. 124 A, B). The enamel pattern on the occlusal surface of the Pm–2 is more elaborate (Fig. 124 B). Each cusp has three ridges, the distal ridge of the buccal cusp meeting the distal ridge of the lingual cusp so as to bound a V-shaped fossa, rather like the ridges which bound the posterior fovea in a lower molar. The ridges may represent the oblique ridge of an upper molar. In none of the specimens are the roots completely formed. A deep groove on the proximal aspect of the root indicates its double nature.

Upper Molars. There are three unworn upper molars among the isolated teeth from et-Tabūn. Two of these, an M–1 and an M–2, belong to Series I; another M–1 belongs to Series II. The measurements in Table LXIV (p. 209) indicate that these teeth are not remarkable, those from Series I falling below the measurements of the corresponding Krapina and Le Moustier teeth. The roots of M–1 are well separated (Fig. 125 D) and there is no taurodontism.

The cusp and ridge pattern of a right M–2 is shown in Fig. 125 A, and in the same figure (B) is the same tooth of the Le Moustier youth; the resemblances in cusp and enamel ridges are unmistakable. The arrangement of the enamel ridges is more regular in the Carmel molar than in that of Le Moustier; amongst the Carmel molars, none show the disorganization (anomoplasia) of pattern so common in the upper molars of the Krapina people. All four cusps are well and almost equally developed in the Tabūn crown; the ridges, fossae, and furrows are explained in the legend of Fig. 125. In the same figure is given a drawing of the crown of the M–2 of Dryopithecus rhenanus. The ridges, pits, and fissures of the Carmel and the Le Moustier crown can be readily identified, with one exception. We must direct the reader's attention to the pattern of the cusp labelled l^2 in Fig. 125 A, B, C, the second lingual cusp or hypocone. The hypocone area is seen to be made up of a series of ridges which stream inwards from the marginal ridge of the crown towards the oblique ridge, from which they are separated by the oblique fissure. In the hypocone area of Dryopithecus rhenanus one of these ridges, the innermost of the series, has become highly specialized, the distal marginal ridges being almost suppressed. Only in this, and the regularity of the ridges, do we see a point that distinguishes this tooth attributed to an anthropoid ape from those which are certainly human.

Carabelli Pit. There is a pit on the protocone (l^1) of Dryopithecus rhenanus which is the initial stage in the production of the Carabelli cusp (Fig. 125 C, *cp*). The same pit is evident in the Carmel and the Le Moustier upper molars (Fig. 125 A, B). It is present

in all the unworn upper molars from Krapina, being best marked in M–1, least in M–3. Jeanselme (1917) found that the Carabelli cusp, or a representative of it, was present in about 50 per cent. of unworn upper molars of Europeans. The pit is almost constant in certain native races, such as the Bushman. It is present in the two upper milk molars of Tabūn Series IV. The Carabelli pit must be regarded as a constant feature of the upper molars of the Neanderthal group, and in this respect the Tabūn upper molars are Neanderthaloid.

Lower Incisors. We come now to a description of the mandibular teeth as represented by isolated specimens in the various Tabūn series. There is only one incisor, the crown of an unworn right lateral; its dimensions are given in Table LXIV, Series II (p. 209). These are large, exceeding the mean measurements for Australian incisors, although the Krapina specimens are almost equally big. Drawings of this incisor crown are given in Fig. 126 A, A′, where the corresponding tooth of a Bushman is given for comparison (Fig. 126 B, B′). The lingual heel of the Tabūn incisor is seen in profile; it projects inwards to an uncommon degree, forming a rounded, smooth elevation with a slight fold on the distal margin.

Lower Canines. Among the isolated Tabūn teeth there is no representative of the lower canine. We have had recourse, therefore, to the dentition of the two Tabūn mandibles where the canines are worn but, as will be seen from Fig. 127, still preserve certain features. Four lower canines are represented in this figure, an American Indian (A), Tabūn I (B), Tabūn II (C), and the Le Moustier youth (D). The lingual tuberosity projects far inwards in the Le Moustier youth, as it does also in the American Indian, but in the former—as is usual in Neanderthal dentitions—a median ridge ascends on the lingual aspect of the crown and the proximal and distal margins of the crown are raised into folds, a feature quite absent in the modern tooth. It is evident that the lingual tuberosity was large and rounded in the Tabūn woman and also prominent in Tabūn II. There are also, in both teeth, traces of a lateral fold but not so developed as in the Le Moustier specimen. Thus, the indications in the Tabūn lower canines are Neanderthaloid.

Lower Premolars. There are, unfortunately, no isolated, unworn lower premolars in the Tabūn series, but from the partly worn condition of the lingual cusp of Pm–1 in the mandible of Tabūn I it is evident that the buccal cusp was much the higher, as is usual in the Neanderthal dentition (Fig. 127 D). The dimensions of the lower premolars are given in Table LXV (p. 210). It is evident from the traces of the enamel pattern preserved in the lower premolars (Fig. 127 B, C), that there had been no disintegration of the normal human premolar pattern.

Lower Molars. There are only two lower molars amongst the isolated Tabūn teeth, one of them an unworn M–1 of the left side, the other a much worn M–3 and both from Layer B (upper Levalloiso-Mousterian). The measurements of both are given in Table LXIV, Series III (p. 209), and the cusp and ridge pattern of the M–1 are depicted in Fig. 128 B, and in Pl. XIV, 12. Similar views of the corresponding tooth of a Bushman are given for comparison (Fig. 128 A) with those of the Le Moustier youth (C), a Krapina molar (D), and of Dryopithecus rhenanus (E). Although the crown of the Tabūn M–1 is approximately square in shape (width 93·5 per cent. of length), only four cusps are differentiated. In Fig. 128 B they are labelled b^1 (first buccal or protoconid), b^2 (second buccal or hypoconid), l^1 (first lingual or metaconid), l^2 (second lingual or entoconid).

The third buccal cusp or hypoconulid (b^3) shown in the other drawings has not been differentiated from the distal marginal area, a sign of retrogression from the plenal molar form usual in the orthograde Primates.

The ridge pattern is remarkable, especially for the development of an oblique ridge which links the second buccal to the first lingual cusp, a development parallel to that seen in the upper molars. The anterior fovea is deep and is bounded behind by a post-foveal ridge. A most remarkable arrangement is seen in the hinder marginal area, the region normally occupied by two cusps, the entoconid and the hypoconulid. The former is definitely present, forming a series of ridges which proceed towards the oblique ridge and from which their ends are separated by the oblique fissure. The whole distal (post-oblique) area is occupied by ridges streaming towards the oblique crest. When we turn to the corresponding tooth of the Mousterian youth (Fig. 128 c), we find a similar arrangement in the proximal area of the crown. This area, made up of b^1, b^2, l^1, ends behind in the oblique ridge, which is not nearly so sharply differentiated as in the Tabūn molar. There is a well-developed entoconid (l^2) on the hinder area from which ridges radiate towards the oblique sulcus. There is a moderately developed hypoconulid (b^3) which sends a ridge inwards to meet with one from the entoconid (l^2), to cut off a posterior fovea (*pf.*). There are two separate distal ridges, pushing into the space of the posterior fovea. It is easy to realize how the arrangement of ridges on the hinder area of the Mousterian molar might pass into that shown in the Tabūn specimen.

The ridges have become more numerous and more disorderly in the Krapina molar (Fig. 128 d), streaming from all the cusps towards the centre of the crown. There is no oblique ridge but the elements which go to form it are evident. Not only are the usual two cusps developed on the distal marginal area, the hypoconulid and the entoconid, but a third has appeared from the marginal ridge, a third lingual cusp (Fig. 128 d, l^3). The posterior fovea is bounded by ridges proceeding from b^3 and l^3. Two marginal ridges project into it as in the Le Moustier molar.

The primitive arrangement of ridges, from which those seen in the Tabūn, the Le Moustier, and the Krapina crowns seem to be degradations, is shown in the lower M–1 of Dryopithecus rhenanus. The anterior fovea is deep, the transverse ridges are orderly, the oblique ridge which joins the metaconid to the hypoconid is wide and strong and the oblique sulcus cuts off the hinder area which carries well differentiated entoconid and hypoconulid cusps. The posterior fovea is really double, being separated into proximal and distal compartments by a ridge thrown out by the entoconid and the hypoconulid. There are suppressed marginal ridges projecting into the fovea. All of these elements seen in the tooth of the extinct anthropoid ape can be identified in the Krapina molar; from the Krapina molar to the Le Moustier is but a step and from Le Moustier to the Tabūn molar is another step on the path of molar retrogression.

It cannot be doubted from the survey of the pattern on the crown of this Tabūn molar that it must be regarded as Neanderthaloid; it seems difficult to believe that a Neanthropic pattern such as that seen in the molar of a Bushman (Fig. 128 a) could be derived from the Tabūn pattern. On the other hand, it is easy to conceive changes which produce the Tabūn pattern from the ancestral type which gave rise to the patterns seen in the Le Moustier and the Krapina molars.

Among the isolated Tabūn teeth is the crown of a lower third molar of the right side.

The cusps are worn off the occlusal surface (Fig. 129 B). The tooth is small as will be seen from the measurements in Table LXIV, Series III (p. 209): the *M–D* diameter, 11·1 mm., the *L–L* diameter, 9·7 mm., the width being 87·6 per cent. of the length. There are traces of five cusps, while the trigonid part of the crown is separated from the talonid portion by an irregular transverse fissure. There is no feature which distinguishes this molar from those of modern races.

Tabūn Eb, Lower Right M–1.

The measurements of this tooth are given at the end of Table LXIV, Series III (p. 209). It is a small tooth and yet it has characters which have led us to regard it as the first lower molar of the right side. The occlusal surface is smooth and polished with the tips of the crowns worn off. There had been the usual pair of flattened roots, proximal and distal, but they are broken away, leaving only the body and the crown; the total height of the specimen is 10·5 mm. (Fig. 129 C). As will be seen from Fig. 129 D five cusps had been present, the fifth or hypoconulid having been much reduced. We can see no feature in this tooth which is not found in modern races. A comparison of the crown of the Tabūn lower M–3 from Layer B (Fig. 129 B) with this molar from the upper part of the Acheulean will show many points of close resemblance, both teeth probably being those of women. Teeth agreeing in character so well, suggest that the Tabūn type had not changed since Acheulean times.

It is also remarkable that in the two complete Tabūn dentitions (Tabūn I, Tabūn II), the first lower molar is short-rooted and its crown relatively small (p. 199).

Complete Dentitions from et-Tabūn

We have considered hitherto, with the exception of the canines, only the isolated teeth of the Tabūn people. Now we shall describe three complete sets, the upper set of the Tabūn woman (Tabūn I), her lower teeth, and the lower teeth of Tabūn II, represented in a powerful male mandible. The measurements of the teeth of these three sets are given in Table LXV (p. 210); comparative measurements will be referred to in the text. A drawing of the dental palate of Tabūn I is given in Fig. 130, and in the explanation to this figure is given a definition of the dental palate. By the dental palate we mean the area included by two lines, the first bounding the buccal margins of the teeth and the second tangent to the distal margins of the third molars. The calculation of the area is done by superimposing a tracing of the palate on millimetre paper and computing the number of square centimetres included within the palatal area. The area of the palate in the Tabūn woman is 32·9 sq. cm. (cf. Table LXVI, p. 211). This is rather more than in the Gibraltar woman (31·6 sq. cm.) but much less than in the palate of La Quina. It is also more than the mean for the dental palate of the Australian (31·6 sq. cm.) but much less than the estimate for the man of La Chapelle (35 sq. cm.). Although the teeth on the left half of the Tabūn palate have been displaced, the right are in their normal position. A glance at Fig. 130 A and B will make clear the resemblances and the differences in shape of the Tabūn and Gibraltar palates. Both are wide and relatively short, but the Gibraltar palate is shaped like a horse's shoe while in the Tabūn palate the molar teeth appear to have diverged slightly. Both are regarded as those of women. Nevertheless there can be no doubt that the resemblance between the two jaws is a close one as regards their general form and dimensions. The width of the Tabūn dental palate, measured between

the most distant points of the buccal aspect of the second molars, is 69·3 mm. Its length measured along *O–O* (Fig. 130) is 55·5 mm.; the width represents 124·8 per cent. of the length. The length in the Gibraltar palate, which may be regarded as representative of the Neanderthaloid palate, is 54 mm., its width, 67 mm., the width being 124 per cent. of the length. The La Quina palate, of great size, had a length of 61 mm., a width of 78 mm. and a width ratio of 127·8 per cent. The Bushman, who has served us for comparison on so many occasions where the Tabūn woman has been concerned, has a palate of somewhat smaller size, being narrower. The length in the Bushman is 55·4 mm., the width, 65·2 mm., the width ratio being 117·7 per cent. In the shape of her palate the Tabūn woman agrees more with the Palaeoanthropic type rather than with the forms existing in modern races.

The most remarkable feature of the Tabūn palate, as well as of the Neanderthal palate, is its width in front, the flatness or squareness of the muzzle. This character is best expressed by the bi-canine width measured between the extreme points of the buccal surfaces of the canines. The bi-canine width is 48 mm. in Tabūn I. It varies from 38 to 40 mm. in modern European women who have well-developed palates. In the Bushman palate here used for comparison it is 40 mm. The width in the Gibraltar palate is 43·5 mm., in La Quina, 49 mm.; the mean for Australian males is 42 mm. This character of the palate, its great width anteriorly, can be best expressed by determining the ratio of bi-canine to bi-molar (M–2 to M–2) width. Treated as an index, the ratio in the Tabūn palate is 69·2; in the modern European, 63, which is also of about the same value as in the average male Australian; in the Bushman it is 61·2, in Gibraltar, 61·2, in the La Quina woman, 63·6. The ratio is high in anthropoid apes. The bi-canine–bi-molar ratio is altogether exceptional in the Tabūn palate.

Another aspect of the dentition of the Tabūn woman which requires attention is the total dental length, the sum of the medio-distal diameters of the crowns of the teeth in one-half of the palate. The right half is the side we have selected. The total dental length is 67·8 mm. It is made up as follows: incisors, 16·3 mm.; canine premolars, 21·9 mm.; molars only, 29·6 mm. The total dental length in the Bushman's palate is almost the same, 67·7 mm., the items making up the total being also similar. The Krapina teeth are bigger in every respect than those of Tabūn I. If we take the mean of the dental measurements given by Kramberger, then the total Krapina dental length may be assessed at 78·1 mm., 10 mm. more than the Tabūn woman. There is an excess in each of the three series of teeth we have distinguished, the molar length being 33·2 mm., as against 29·6 mm. in Tabūn I. The length is shorter in all three sections of the palate of the Spy woman (Spy 1), the total being 59 mm. The Krapina dental measurements exceed the mean value for Australians while the Tabūn and Spy figures fall short.

The characters of the individual teeth are brought out in the drawing we give of the dental palate of the Tabūn woman (Fig. 130 A). Although the crowns of the incisors and canines are worn down, the tuberculated lingual heels are still apparent and were of the nature described previously (pp. 191–2). The presence of such lingual heels gives the Tabūn incisors a relatively great labio-lingual diameter (Table LXV, p. 210). This is a character of Neanderthaloid dentitions. For example, the *L–L* diameter represents 91 per cent. of the *M–D* diameter in the first and 105·4 per cent. in the second incisor of Tabūn I, whereas in a modern dentition such as the Australian the ratios are 85 and 90 per cent.

respectively. The proportions are 90 and 110 per cent. in the Krapina incisors. The incisors of the Tabūn woman place her in the Neanderthaloid group.

The premolars offer no particular feature. The first and second molars, however, are almost square in the crown, each has four cusps, all four are well developed, and the oblique ridge had been well defined. The third molar, preserved only on the left side, lacks a hypocone and has a triangular shape with three cusps. The Carabelli pit is still evident in the first molar (Fig. 130 A, *cp*), a trace is recognizable in the second, but no trace of this structure is to be seen in the third molar.

The lengths of the roots can be inferred from the measurements given in Table LXV (p. 210); they are shorter than those of Krapina. As far as can be determined from the skiagrams, the upper premolars were single rooted; each molar had three roots, but from the tracing of a skiagram given in Fig. 132 B (p. 208) it will be seen that there is a progressive approximation of the two buccal roots from M–1 to M–3. The pulp cavity is relatively large, that of M–1 being 2·2 mm. in its *M–D* diameter and 2·2 mm. high; of M–2, 2·5 × 2·5 mm.; of M–3, 2 × 7 mm. Thus, although taurodontism has not reached the amount seen in many of the Krapina molars, a certain degree of this degenerative change is evident in the molars of Tabūn I. Here again is a feature which tends to place this woman in the Neanderthaloid group of ancient humanity.

Complete Lower Dentitions

Measurements relating to the individual teeth of the mandibles of Tabūn I and of Tabūn II are given in Table LXV (p. 210), while those which relate to the dentition as a whole are given in Table LXVI (p. 211). Drawings of the two dentitions are given in Fig. 131 A, B, C, D, where they are compared with dentitions from Krapina (Krapina H and I). These are chosen because they stand nearer to the Tabūn specimens than any other prehistoric mandibles known to us.

The size of the woman's mandibular dental area, measured by the method used for the upper dentition (p. 195 and Fig. 131), is 31·1 sq. cm., about 2 sq. cm. less than the upper area (32·9 sq. cm.). In Krapina H, which we regard as the mandible of a woman, the area is slightly less (30·9 sq. cm.), and that of Spy I (30 sq. cm.), also female, is still smaller. The length of the lower dental arch is given in Table LXVI (p. 211); that of the Tabūn woman is 54 mm., the same as in Spy I (54 mm.); but in the Krapina woman this diameter is 58 mm., the Krapina teeth being as a rule larger than those of Tabūn. The Spy specimen is the greatest as regards widths, the Bushman's the least (Table LXVI, p. 211). The width in the Tabūn woman is 122·9 per cent. of the length, while in Spy I the proportion is 125·9 per cent., in Krapina H 111·2 per cent., in the Bushman 109 per cent. The modern Bushman in this respect is the more simian, for in the apes the dental areas are long and narrow. The most outstanding feature of the lower dentition of Tabūn I is, as was the case with her palate, its width in front as indicated by the bi-canine width measured as in the upper jaw (Table LXVI, p. 211). It measures 38 mm., 1 mm. more than in the Krapina mandible, 2 mm. more than in Spy, and 6·7 mm. more than in the Bushman mandible. The mean for English male mandibles is 31 mm.

It is of interest to look at the total dental length as indicated by the sum of the mediodistal diameters of the crowns (Table LXVI, p. 211). The Tabūn mandible (65·4 mm.)

in this respect falls far below the Krapina specimen (72 mm.) but is greater than the Bushman and much greater than the woman of Spy.

The mean width of the three molars is compared with their mean length (*M–D* diameter) in Table LXVI (p. 211). The Krapina molars are the most primitive of the series compared, the width being 87·9 per cent. of the length; it is 96·2 per cent. in the Tabūn lower molars and 97·2 per cent. in the Bushman, while in the Spy molars, much reduced in their length, the width ratio rises to an exceptional proportion, 101·9 per cent.

The characters of the individual teeth are shown in Fig. 131. The Neanderthaloid features of the Tabūn teeth are notable; they are present to their full extent in the Krapina mandible, where there is an exaggeration of the lingual tubercle of the incisors, particularly in the lateral incisors. The characters of the canines and premolars we have already touched upon (p. 211). Although all five cusps are represented in the Tabūn molars, the hypoconulid (b^3) is differentiated to only a slight extent, particularly in the second molars. We note, too, the tendency for the furrows behind the two proximal cusps (trigonid) to assume a complete transverse pattern as in modern molars.

A consideration of all these features of the lower dentition leaves us in no doubt as to the Neanderthaloid status of the Tabūn woman, and yet her dentition is nearer to that of primitive living races than are the Krapina dentitions.

The teeth of the large male mandible, Tabūn II, are seen in Fig. 131 C, the sagittal length of the dental arch being 59 mm. (Table LXVI, p. 211). The bi-molar width is 66·2 mm., the width representing 112·2 per cent. of the length, almost the same as in the female Krapina specimen (H). The Krapina male (I), with which we have compared the Tabūn specimen, is only 54·5 mm. long but is 72 mm. wide, the width representing 132·1 per cent. of the length. If we compare the Tabūn arch with that of the Heidelberg mandible we find many points of correspondence. The length in the Heidelberg specimen is only 1 mm. more, namely 60 mm., but the width is slightly greater, 68 mm. and the width ratio 113·3 per cent. We look upon the Tabūn-Heidelberg proportions as being more simian (i.e. less modified) than in the case of the Krapina mandible.

It will be seen from Table LXVI (p. 211) that the Tabūn II dental arch, as regards area, stands high in the records of early man. The area in the Krapina mandible (Krapina I) is 30·7 sq. cm., surprisingly small when we consider the massive framework of the lower jaw. The area in the Heidelberg mandible reaches the high figure of 34·6 sq. cm.; the Tabūn area is 32·7 sq. cm., rather less than 2 sq. cm. below the figure for Heidelberg.

The bi-canine width which was so great in the Tabūn woman is slightly less in the Tabūn man but is yet great when compared with both modern and ancient dentitions. It is 37·3 mm. compared with 36·2 mm. in the famous Heidelberg mandible and 34 mm. in Krapina I. Both the Tabūn man and the woman had wide muzzles; the upper bi-canine width in the male must have been in the neighbourhood of 48 mm.

The Tabūn II mandible as regards its total dental length (69 mm.) stands 4·5 mm. below Heidelberg (total 73·5 mm.) but is 2·8 mm. more than the Krapina I specimen. The mean length of the three molars of the Tabūn jaw is 11·1 mm., the same as in the Krapina specimen but considerably less than in the Heidelberg jaw (mean, 12·4 mm.). The mean molar width in the Tabūn mandible is 10·9 mm., being 98·2 per cent. of the length; the molars are nearly square. The width proportion in the Krapina molars is 93·7 per cent. and in Heidelberg 93·5 per cent., the latter figures being the more simian or primitive.

The teeth of the Tabūn male are worn on the crowns, so that the cusp pattern has been erased, although in the third molars traces are left of five cusps in each. The lingual tubercles of the incisors and canines were less developed than in Tabūn I, and in this respect the male makes a nearer approach to the teeth of the modern living races. We can distinguish no difference in the general shape of the crowns of the teeth when we compare the male and female Tabūn dentitions; they seem to be of the same type. In both the upper and lower premolars of Tabūn I and in the lower premolars of Tabūn II, the buccal swelling of the crown, which Adloff (1907) has named the tuberculum premolare, is moderately developed.

Tracings taken from skiagrams of the molar regions of the Tabūn jaws are shown in Fig. 132, p. 208 (also Pl. XXVI). There is an incipient taurodontism in the upper molars of the Tabūn woman (Fig. 132 B; Pl. XXVI G), and this is to be seen in a lesser degree in her lower molars. The pulp cavities are larger than is usual in the molars of living native races. The roots are stout, short, and well separated at their apices. The molar roots in the male Tabūn mandible (Fig. 132 C) are long, stout, well separated, and there is no taurodontism. The pulp cavities are almost filled up, a consequence of wear, but it is clear that the cavities had increased in size from the first to the third tooth of the series.

There is one striking point of resemblance in the Tabūn skiagrams—the shortness of the roots of the first molar. This tooth is formed while the jaws are still small, and in big-toothed primates it is often the shortest rooted and smallest of the molar series. An estimate of the length of the roots can be obtained from the measurements given in Table LXV (p. 210) by deducting the crown height from the total length of the tooth, and also from the skiagrams given in Pl. XXVI. As already noted (p. 195), the small size of the lower molar from the lower strata of et-Tabūn may indicate the existence of this character in the early inhabitants of the cave.

SKHŪL DENTITIONS (Pls. XIV, XXVI, XXVII)

It has been explained elsewhere (*vide supra*) that we commenced our systematic examination of the Mount Carmel material at the foot and worked upwards in limbs and trunk, leaving the skull, jaws, and teeth to the last. In the course of this examination we have been impressed with the multitude of anatomical points in which Tabūn I differed from the inhabitants of the Skhūl cave. The Tabūn woman's features are predominantly Neanderthaloid, while the Skhūl people possess many traits which ally them with early Neanthropic peoples, especially those of the tall Cromagnon type. We therefore determined, when we came to deal with the teeth, to separate those which came from et-Tabūn and deal with them first. This we have just done and proceed now to give a systematic account of the Skhūl dentitions.

The dental material from the Skhūl cave is as follows:

Skhūl I. See Chapter XIX for the detailed description of the dentition of this infant.

Skhūl II. There is a fragment of a female mandible (p. 222). In addition there are the upper right canine, Pm–2, M–1, M–2; lower left I–1, both lower canines, and the lower left Pm–1, Pm–2, M–2.

Skhūl IV. The upper and lower dentitions are nearly complete. In the upper jaw the right Pm–2 is lacking and the crown of the right I–2 is broken away. The crowns of the lower left canine and I–2 and the right I–1 are defective.

Skhūl V. The upper dentition is complete, while the lower jaw lacks only the right Pm–1, lost before death.

Skhūl VI. Part of the left half of the mandible remains, bearing the M–3 and the roots of M–2. The crown of the latter forms a separate fragment. The crown and neck of the lower Pm–1 of this side are preserved. The upper left canine and the crown of the right M–1 are also present.

Skhūl VII. The six lower molars of this woman are preserved in the mandibular fragments. Both first molars are damaged. On the left side are the roots of the two premolars and of the lateral incisor. The left I–1 and I–2, the three molars of the right side, and the M–2 and M–3 of the left side of the upper jaw remain.

Skhūl X. This child is represented by a symphysial fragment of the mandible (p. 224, and Figs. 138, 157). The teeth remaining are the i–1, i–2 (right), and the i–1 (left) and the unerupted crowns of the permanent incisors and canines. Part of the body of the mandible of the left side remains and carries the m–1 (incomplete), the m–2, and the unerupted Pm–1. The crown of the lower left M–1 is also present. The upper teeth remaining are the crowns of the right Pm–1, left canine (fragment), left M–1 and the crown of the right M–2.

First we shall proceed to give an account of the two complete dentitions, those of the tall men, Skhūl IV and V, beginning with the palate of the latter. It will be recalled that in certain features of his ribs and vertebrae he showed Neanderthaloid affinities. The dental palate of this individual is compared in Fig. 133 with the exceptionally large palate of a male Australian. The measurements are given in Table LXVII (p. 211). The palatal area is very large, 36·3 sq. cm., being 3·4 sq. cm. greater than in the Tabūn woman, but only 1·7 sq. cm. larger than in the Australian; the dental palate of the man of La Chapelle was probably as great as that of Skhūl V. The width of the palate of Skhūl V is 116·4 per cent. of the length, that of the Tabūn woman is 124·8 per cent. (8 per cent. greater), and that of the Australian 113·1 per cent.). We meet, however, with the wide muzzle we found in the Tabūn jaws. The bi-canine width is 46·4 mm.; it is almost the same in the Australian but it was greater (48 mm.) in Tabūn I. We are dealing with a feature which we may suppose to characterize all early races of mankind; it does not help us very much to draw a sharp distinction between the Tabūn and the Skhūl palate.

We may also note some other points recorded in Table LXVII (p. 211). There is first the total dental length, the combined medio-distal diameters of the teeth of one side. The sum is only 68·3 mm. in Skhūl V, almost the same as in the Tabūn woman, while in the Australian it amounts to 70·7 mm. We note as before (p. 198) the mean molar length and mean width; the length is 10·3 mm., the width 12·2 mm., the width ratio 118·4 per cent. The dimensions and proportions are different in the Tabūn woman (Table LXVI, p. 211), her molar proportion being 113·2 per cent. Tabūn I is more primitive than Skhūl V in the great palatal width, in the large bi-canine width, the relatively greater dental development, and the relative narrowness of the molars, but there is nothing to suggest a genuine racial difference. The mandibular dental arch of Skhūl V is compared with that of the Australian in Fig. 134. The mandibular area is remarkable in Skhūl V in that it is almost as large as the upper dental area, a tendency towards this condition being a feature of the Tabūn woman. In modern mouths the lower area is usually about 2 sq. cm. less than the upper; in the Australian here used for comparison the difference is 1·4 sq. cm. The

mandibular area of Skhūl V is larger than that of the Heidelberg jaw (Table LXVI, p. 211). The feature of the Skhūl mandibular arch which catches the eye in Fig. 134 is its great width in the canine and the premolar region. The front portion of the dentition had been distorted both from use and post-mortem accident but, making allowances on this score, the bi-canine width was great, 41·3 mm. (Table LXVII, p. 211), much greater than in either Tabūn I or Tabūn II and 5·3 mm. greater than in the Australian mandible. We have further evidence here of a wide muzzle, a feature already noted of the Tabūn dentition. The arch in the Australian mandible is longer than that of Skhūl V.

We may turn now to the palatal and mandibular areas of Skhūl IV. The characters and the dimensions of the teeth in this man, as we shall see presently, are Neanthropic. His palatal area (Table LXVII, p. 211) is only slightly less than that of Skhūl V but, being short, its width proportion is very different. The width is 129 per cent. of the length, compared with 113·1 per cent. in the Australian and 116·4 per cent. in Skhūl V. Both upper and lower arches are not only relatively but absolutely wide as may be noted in Fig. 135. We have seen how wide is the Gibraltar palate (Fig. 130 B); in its proportions the palate of Skhūl IV is Neanderthaloid. The palate of the Australian, on the other hand, represents the simian or primitive form. In Skhūl IV we meet with the same muzzle as in Skhūl V, where the upper bi-canine width is the same in both. In Skhūl IV, however, the lower bi-canine width was *c.* 36 mm., the same as in the Heidelberg jaw and also in the Australian mandible (Fig. 134).

The upper dental length of Skhūl IV amounts to 70·3 mm., rather greater than in Skhūl V, but less than in the Australian (Table LXVII, p. 211). The lower dental length, however, is only 65·5 mm., the wide squat form of the arch being quite apparent in Fig. 135 B. Its width proportion is about the same as in the upper jaw, namely, 133 per cent. The upper molars have a mean length of 10·1 mm., a mean width of 11·9 mm., the width ratio being 117·8 per cent., almost the same as in Skhūl V (Table LXVII, p. 211), but less than in the Australian where, as is usual in that primitive stock, the molars are very wide. The lower molars of Skhūl IV are small, the mean length being only 10·9 mm., the mean width 10·6 mm., and the width ratio 97·2 per cent. The width ratio in the Australian is 100 per cent., and in Skhūl V 98·2 per cent.

Thus in our survey of the complete dentitions and palates of the Skhūl people, although it has brought out certain points where the Skhūl type differs from the Tabūn, in the main resemblances predominate over differences. In both types there is a very wide muzzle and a dental arch which tends to assume the horse-shoe form. The great width of the dental arch was already apparent in childhood, as may be seen from the mandible of the child, Skhūl I (Fig. 156).

The degree of wear of the crowns in Skhūl IV and V will be evident from the drawings (Figs. 133, 134, 135). The lower teeth are more worn than the upper in Skhūl V, with the right lower M–1 the most eroded by use. The incisors and canines met edge to edge. The wear in Skhūl V is such as we may expect in a modern native early in the fourth decade of life. The teeth are somewhat more worn in Skhūl IV than in Skhūl V, the tooth most eroded again being the lower right M–1. One can see in the wear of the crowns of the upper incisors evidence of a tendency for them to overlap slightly the lower incisors when biting.

The dentitions of both Skhūl IV and Skhūl V give striking evidence of correlated

anomalies. We have drawn attention to the extra buccal cusp on the upper left M–3 and a malformed area in the corresponding lower molar of Skhūl V (Figs. 133 A, 134 A). A little reflection will suffice to convince the reader that the upper and the lower teeth which come into contact with each other in chewing must develop harmoniously; if an alteration is effected anywhere—or everywhere—in the upper set, corresponding changes must be carried out in the lower set. In brief, there must be a mechanism (a hormone) at work during the development of the teeth which co-ordinates the size and the position of cusps and crowns. The example cited in Skhūl V can be explained only on such a supposition.

A similar developmental error has appeared during the eruption of all four second premolars in the dentition of Skhūl IV (Fig. 135 A, B). The crowns are so arranged that the normal buccal surface is directed towards the first premolar, while the distal surface looks outwards towards the cheek. Although the second upper premolar is lost on the right side, the dimensions of the gap left between the Pm–1 and M–1 tell us that the longest diameter of the missing tooth had been in the axis of the arch. Here, too, we have evidence of a mechanism co-ordinating the same units in the upper and lower jaws.

Other Skhūl Dentitions.

The dentition of Skhūl I (a child) is described in detail on pp. 302–7; several of its teeth are shown in Figs. 137, 138 (Pl. XIV, 3, 4, 5, 7, 8, 9). The chief dimensions of this child's teeth are given in Table LXVIII (p. 212), from which may be obtained information regarding the teeth actually recovered. In our original survey of the dentition of this child we noted that it was distinctly 'Neanderthaloid'.[1] Now that we have studied the dentition of all the Skhūl people, we reaffirm that conclusion, but its agreement is with the Skhūl type rather than with that of Tabūn. For instance, the upper central incisor has an elevated lingual tubercle on the crown, but in its shape and degree of separation from the rest of the crown it resembles the other Skhūl teeth, not those from et-Tabūn (Fig. 121 C). On the other hand, the upper central incisor of the milk dentition is shaped exactly as is the specimen from the Tabūn cave (Fig. 121 A). The upper lateral incisor and the upper canine teeth show Neanderthaloid features (Figs. 137, 138; Pl. XIV). The canines, both of the milk and of the permanent dentitions, are hard to distinguish, tending to assume characters usually confined to the lateral incisors and first premolars. Taking the evidence as a whole, the dentition of the Skhūl child is true to type, possessing features characteristic of the Skhūl type and others peculiar to Neanderthaloid dentitions. On the protocone (l^1 cusp) of the upper M–1 there is a fossa or pocket on the enamel (Fig. 139) which represents the extra cusps described by Carabelli. This pocket in both the Tabūn and Skhūl upper molars assumes a peculiar form—that of a swallow's nest. Similar Carabelli pits occur in the upper molars of modern races, especially Bushmen.

Skhūl X (Figs. 138 D, F, 141 E, F; Pl. XIV, 10, 13).

The child known as Skhūl X was at least a year older than Skhūl I. It is probably a boy, the other perhaps a girl. Of its body we have only the distal half of the right

[1] Skhūl I was discovered in 1931, the technical preparation largely completed by March 1932, and its publication as a separate monograph was to follow. The discovery later in 1932 of the Skhūl and Tabūn cemeteries necessarily altered this scheme. (See Garrod and Bate, 1937.)

humerus. This bone, in its size, suggests a child of about 5–6 years of age. The state of the teeth suggests a younger age, although the premolar crowns are already formed. The front part of the mandible is preserved and in it are embedded the unerupted, fully formed crowns of the incisor and canine teeth, the pre-molars, and M–1. The teeth at our disposal are listed with the measurements in Table LXVIII (p. 212). The milk incisors have only the edges worn from their crowns. The cusps of the lower second milk molar have the same quartz-like crystalline appearance as the cusps in Skhūl I. The teeth are Skhūl, not Tabūn in their markings. The Carabelli pocket, so well developed in the Skhūl I first molars, is just discernible in what we regard as the upper first molar of Skhūl X, and is quite absent in the upper second molar. Indeed, it was on re-examining the two loose upper molar crowns that it became apparent that they were not the right and left first molars, but the first of one side and the second of the other. It is remarkable to find the crown of a second upper molar tooth completely formed when all the permanent teeth lay within their alveoli. The cusps of the permanent molars are high, steep-sided, and of a pyramidal shape. There are four fully developed cusps for the upper and five for the lower molars in Skhūl X, as there were in Skhūl I. The enamel pattern is more crenellated and less crystalline in appearance in the permanent than in the milk teeth of both Skhūl I and Skhūl X. The crown of an upper first premolar is shown in Fig. 138 F, and that of a lower canine in Fig. 138 D.

Skhūl II.

We attribute this series of teeth to a woman in about the fifth decade of life. They are enumerated with their respective measurements in Table LXVIII (p. 212). The symphysial region of the mandible is preserved and is entirely feminine in character (Fig. 153). The lower incisor, canine, and premolar teeth are deeply worn, so that their identification was not easy. The chewing surface of the two upper molars is worn flat, but their cusp pattern may still be traced. The hypocone (l^2) is small in M–1 and almost absent in M–2. All the teeth have short roots—flat and wide in the upper premolars (Fig. 138 E), while the buccal roots of the upper molars are appressed, almost fused, the roots exhibiting a tendency towards taurodontism to an extent often seen in the upper molars of Bushmen. The crowns are strongly convex on their buccal aspects. The lower M–2 (Fig. 140 C, D) is a remarkable tooth in several respects. The two roots are separate on their lingual aspect but are joined along their buccal margins. The furrows between the cusps are arranged in a true cruciform pattern, the third buccal cusp being represented by a mere cuspule. There is a slight degree of taurodontism.

The two lower canines placed in position in their sockets give a bi-canine width of only 31·4 mm., a measurement quite common in the dentitions of modern European women. These teeth are similar to the canines of Skhūl V, but smaller.

Skhūl VI.

The measurements of the teeth of this individual—a man—are given in Table LXVIII (p. 213). Fortunately the upper left canine was still in place within a fragment of the maxilla, otherwise we should have been inclined to regard it as a lower Pm–1, so premolariform is its crown (Fig. 138 A, B). The degree of wear in the molars is about the same as in Skhūl IV and V. The crown of the upper M–1 is wider than long and the hypocone

is well developed. Unfortunately the enamel has been broken away from the crown of the lower M–2; if a third buccal cusp was present it must have been small.

The left M–3 is retained within a fragment of the mandible (Pl. XXVII E); it has five conical cusps with a smooth covering of enamel, and the hypoconid, hypoconulid, and entoconid cusps are of about equal size. There is no posterior fovea.

Skhūl VII.

These teeth belong to a woman, and from the degree of molar wear we infer that she was probably in her fourth or fifth decade. The dimensions are given in Table LXVIII (p. 212). There is the greater part of the lower jaw, unfortunately much crushed, but showing in the symphysial region the same sub-alveolar development in the lingual aspect which we shall describe (p. 216) in the mandible of the Tabūn woman. It will be remembered that the forearm bones have the same great bending as in Tabūn I. What is even more important is that the upper incisors, both medial and lateral, of Skhūl VII have the same form and size as the incisors of Tabūn I. We regard these teeth as the most characteristic of the Tabūn dentition, and Skhūl VII has the characteristic Tabūn pattern. A comparison is made between the two sets in Fig. 136. In this figure examples are given of the corresponding incisors of Skhūl V and of an Australian. The incisors of Skhūl V—and the same is even more true of Skhūl IV—are modern or Neanthropic in form. The chief difference between the Skhūl and Tabūn dentitions lies in the patterns of the incisor crowns.

The crowns of the upper molars of Skhūl VII have a remarkable shape (Fig. 140). Their occlusal surface is trapezoidal in outline, this being due to an exaggeration in size and in lateral prominence of two cusps, the paracone (b^1) and the hypocone (l^2). There is an exaggeration of the same two cusps in the upper molars of the Tabūn woman (Fig. 130 A), but not to the same extent. The two buccal roots of M–1 in Skhūl VII are separate only in their terminal halves; and in M–2, though the roots are crushed and broken, they seem to have been conjoined. Both molars show an exaggeration in size of body; there is a considerable degree of taurodontism, more than in Tabūn I. Yet, strange to say, the left M–3 has its two buccal roots separated for a distance of 12 mm., the total length of the entire tooth being *c.* 20 mm., the height of the body and crown being only 7 mm. The two distal cusps (hypocone and metacone) of the crown of the M–3 are reduced to form a mere margin to the tooth.

We can say very little of the lower molars. The crowns are greatly worn, the dentine being exposed over the entire occlusal surface of M–1, and only traces of the enamel are left on the others. The occlusal outline of the M–3 indicates a well-developed hypoconulid, and this tooth is broader and longer relative to the M–2 than is the Tabūn I M–3. One significant fact is to be noted in Table XLVIII (p. 212) and in the skiagram in Pl. XXVI. The first molar is short-rooted, both relatively and absolutely, in this respect recalling the condition previously remarked in the first molars of Tabūn I and II. This is another indication of a relationship between the Tabūn and Skhūl peoples. The moderate degree of taurodontism in the Skhūl VI molar (Pl. XXVII E) is another link.

In this section dealing with the teeth of the Skhūl people we have passed in review the individual dentitions, giving an account of the complete forms found in the two men, Skhūl IV and V. We have already touched upon the character of the incisor and canine

teeth and given a series of drawings to illustrate the characteristic features of the Tabūn and Skhūl types of incisors. We had hoped that the greatly developed lingual tubercle of the incisor crowns would give the Tabūn incisors an increase in their labio-lingual diameters and that a relative increase in this diameter over the medio-distal might provide a differential test for the Tabūn and the Skhūl types of teeth. Hence we have drawn up Table LXIX (p. 214) in which are compared the mean measurements of the Tabūn teeth with those of Skhūl, Australians, and the Krapina people. Though the Krapina teeth are larger, there cannot be any doubt that the Tabūn dental type has many resemblances to that of Krapina. Table LXIX does bring out certain characteristic features of the front teeth of the Mount Carmel people. The labio-lingual diameters of the crowns, and the same is true of the roots, are absolutely great and usually relatively great. There is a descending series in the labio-lingual diameters of the upper I–1 beginning with the chimpanzee and running in sequence through Krapina, Tabūn, Skhūl, and Australian to the miscellaneous Modern group. The upper I–2 gives us more definite information in that the width of the Skhūl tooth is nearer to the Australian than to the Tabūn value. The lower medial incisor is intermediate between the Tabūn and Australian widths, but the lateral incisor tends towards the measurements for modern teeth, as represented by the Australian.

An interpretation of the data relating to the canine teeth is not so easy to make. The Krapina upper canine is the largest in our series, then comes the Skhūl and then the Tabūn canine. It will be noted, however, that in the size of upper canines the Australians follow the Krapina examples, and are larger than the Skhūl figure. Primitive modern man, as represented by the Australian, has a large upper canine and in this respect the Skhūl people resemble the Australians as much as they do the Krapina folk. The lower canine series arranged according to the decreasing values of the absolute measurements is Krapina, Tabūn, Australian, Skhūl (Table LXIX, p. 214). This analysis supports our contention that the Skhūl incisors and canines tend towards the modern type, while the Tabūn forms go in an opposite direction, towards the Krapina type.

A series of drawings, shown in Fig. 137 and photographs (Pl. XIV) will help to illustrate the characters of the Skhūl dentition. All the examples are from the child, Skhūl I, with the exception of an upper I–1 (C) from Tabūn Series IV. The resemblance of this tooth to the corresponding tooth of the Skhūl child is evident. The crown of the upper I–2 of the child (D), although spoon-shaped, does not possess the typical pad-like lingual tubercle of the corresponding Tabūn tooth. In the crown of the upper permanent canine (Fig. 137 E) there is a mixture of characters borrowed from its neighbours, the lateral incisor and the first premolar. The milk canine (F) is much simpler although it, too, has certain incisiform features. The lower first milk molar has a well-marked anterior conule, but the swelling in the anterior part of the crown (the tuberculum molare of Adloff) is less developed than in many modern first molars.

The characters of the Skhūl canines and premolars are illustrated in Fig. 138. The upper left canine of Skhūl VI (male) (Fig. 138 A) is still *in situ* in a fragment of the maxilla. The tip is worn off. Its premolariform character is quite evident when the view of the occlusal surface (Fig. 138 B) is compared with that of the left mandibular first premolar (Fig. 138 C). In the case of Skhūl II, we had identified a worn tooth as the lower left canine; subsequently it was determined to be the lower left premolar, so great is the

tendency of the canines to assume a lower premolariform character in the Skhūl dentition. The unworn lower canine (Fig. 138 D) cannot be so mistaken.

The proximal aspect of an upper Pm–2 is shown in Fig. 138 E, the root being separated into buccal and lingual moieties by a deep groove. The cusps, ridges, and furrows are very strongly developed in the unworn Skhūl premolars, as is clear from Fig. 138 F. A corresponding tooth from Tabūn Series V (Fig. 138 G) has the smooth features of the Neanthropic premolars.

The molar teeth of Skhūl I are depicted in Fig. 139 and are represented in Pl. XIV. Four of the drawings represent milk teeth: A, the first upper milk molar has all the essentials of the true upper molar, but the general appearance is that of a premolar; B, the second milk molar, simple in design with a high oblique ridge and a 'swallow's nest' Carabelli pit on the protocone. The resemblance of the upper M–1 to the tooth just described is striking (Fig. 139 B and D); the permanent tooth differs from the milk tooth in the irregular breaking up of its enamel ridges and borders. Fig. 139 C represents the lower left m–2. As in the case of the upper m–1 the lower m–1 was apparently a hybrid tooth showing all the elements of the full molar on a premolar basis. The lower right m–2 is shown in Fig. 139 E. There are the usual five cusps, all pyramidal in shape and prominent; there are anterior and posterior foveae; in brief, a lower molar with the full Dryopithecus pattern. The cusp form of the lower right M–1 is reproduced in Fig. 139 F. Like the first upper permanent, this tooth reproduces the basic pattern of its predecessor, adding detail in the elaboration of the ridges and pits. From what we have said it will be realized that the Skhūl molars, milk, and permanent, retain many primitive features.

Other aspects of the molars of the Skhūl people are shown in Fig. 140. It will be recalled that the Skhūl woman (VII) has many points of resemblance to the Tabūn woman. Views of the worn occlusal surfaces of the two upper molar teeth, M–1 and M–2, are presented in Fig. 140 A, B. Although wear has exposed the dentine at the bases of the cusps, the oblique furrow and ridge may be traced. The features to be noted are: (1) the hypertrophy of the hypocone; (2) the prominence of the paracone; (3) the trapezoidal form of the crown brought about by the enlargement of the two cusps just mentioned. The molar form met with in another Skhūl woman (II) is illustrated in the same figure (C and D). The roots are thick and short and the crowns have strongly convex buccal and lingual surfaces. Another study in Skhūl molars is given in Fig 140 E, where the three upper molars of the right side of Skhūl IV are drawn in profile. There is some degree of taurodontism. Also it is strange to meet with longer and stronger roots in a third than in a second upper molar (Fig. 140 E); the same condition occurs in another Skhūl man, Skhūl VI.

We complete our survey of the Skhūl dentition in Fig. 141 by comparing the Skhūl forms with examples from other Palestinian sites. The lower right molar (Fig. 141 A) was found in the Mousterian strata of the cave of Shukbah in the Judaean hills (Keith, 1932, p. 205). The cusp and ridge pattern is given in Fig. 141 A′. The resemblance of this pattern, and the root and crown form, to the molars we have been describing lends support to the idea that the Mount Carmel people were spread over the land in Mousterian times.

The lower molar illustrated in Fig. 141 B is a very different type, with long separate roots and relatively low crown and short body. Yet it was found by Miss Garrod deep in the Mousterian deposits (Layer G) of the Mugharet el-Wad (Garrod and Bate, 1937,

p. 25). It is so unlike all the other molars from the Mousterian deposits of Mount Carmel that on anatomical grounds we suspect it may be out of place. The lower molar illustrated in Fig. 141 C, D, represents a type which is not uncommon amongst the Tabūn and Skhūl teeth. The roots, while separate along their lingual margin, are joined on the buccal aspect. There is in this type of lower molar a certain degree of taurodontism (Fig. 141 A, C, D).

Lastly, in Fig. 141 E, F, we give two further illustrations of the morphology of the lower molars, milk and permanent. These are from the child, Skhūl X, and a comparison with Fig. 139 E, F, will show how closely they agree with the teeth of Skhūl I. These two children of the Skhūl group agree in their molar characters. In all the lower molars one notes the oblique ridge which links the hypoconid (b^2) to the metaconid (l^1).

We have to admit that the cusp pattern of the upper and lower molars, interesting as they are, do not help us to draw any distinction between the Skhūl and the Tabūn people; the molar patterns seem to be alike in both. The root form of the molars is more helpful as a guide to classification than is the cusp pattern. On the other hand, the front teeth, particularly the upper incisors, do provide clues to relationship and yet if we attempt to separate the Tabūn and the Skhūl types on the basis of their incisor and canine characters, we have to confess that a sharp line cannot be drawn. The woman, Skhūl VII, has nearly all the characters met with in the dentition of the Tabūn woman. We desire to stress, however, the modern nature of the dentition in the two Skhūl men, IV and V. It is true that there are in their teeth minor features of a Neanderthaloid nature, yet had we found their dentitions apart from their skulls and skeletons and culture we should have never hesitated to assign them to the family of modern living races. We have to note too that among the Carmel teeth are found all degrees of transition, which link the Tabūn type with Krapina and with Skhūl, and Skhūl to modern or Neanthropic types.

Fig. 142 consists of tracings from skiagrams of some of the Skhūl dentitions (see also Pls. XXVI, XXVII). The pulp cavity of the lower m–2 of Skhūl I (A) is seen to be large and the roots placed widely apart. The pulp cavity in the lower M–3 of Skhūl VI (male) (B) extends downwards and the roots are appressed, showing a degree of taurodontism. In (C) is a tracing of the lower molars of Skhūl V; there is no taurodontism, the pulp cavities are shallow and are in process of being filled with secondary dentine. The roots are separate and are not long, short roots prevailing generally in the Skhūl dentitions. Except for the thickness of the molar roots there is no feature which distinguishes the lower molars of Skhūl V from those of a modern dentition. The lower left premolars and molars of Skhūl IV are shown in (F). The third molar is missing. The crowns are more worn than in Skhūl V, the pulp cavities are almost obliterated and the roots are thick, separated, and of moderate length. Neither in Skhūl IV nor in Skhūl V is to be seen the short-rooted first molar which forms so noteworthy a feature in the two Tabūn mandibles and in Skhūl VII. We are inclined to attach importance to this feature. The skiagram also shows plainly the rotated position of the Pm–2 (p. 202).

Tracings from the skiagrams of the upper molars of Skhūl V are shown in Fig. 142 E. The exposure was necessarily an oblique one and the teeth are foreshortened. Nevertheless it is clear that the roots are short and the two buccal ones are closely appressed in M–1 and M–2. All three roots are appressed or fused in M–3. The pulp cavities were in process of filling up and do not seem to have been large.

Lastly in (D) is a tracing of the upper central and lateral incisors of Skhūl V (see also Pl. XXVI F). The roots have the same shape and thickness as those of the Tabūn woman (Fig. 136). Thus among the Mount Carmel people we find two types of dentition, the Tabūn, represented by that of the Tabūn woman (Tabūn I), and the Skhūl, best represented by the dentitions of the two men, IV and V. Between them we find transitional forms, so that there is no clear-cut line of demarcation. The Skhūl woman (VII) has a dentition of Tabūn type. We seem to be dealing with the same stock, a Palaeoanthropic or Neanderthaloid stock, with one form (Tabūn) tending towards the extreme dental condition found in the Krapina Neanderthaloids, the other (Skhūl) tending towards the form found in Neanthropic or living races.

Before concluding the chapter on the teeth it will be helpful to add a brief note upon the wear and diseases of the teeth. There is not a trace of caries in any tooth, either *in situ* or loose, in the assemblage from Mount Carmel. The teeth and gums in Tabūn I and Tabūn II are absolutely healthy. In Skhūl IV there is a suspicion of wasting of the inner alveolar margin, but this is more likely due to post-mortem crumbling than to pyorrhea. The anomalous position of the second premolars has been described on p. 202.

There is unmistakable evidence of abscesses at the roots of some of the teeth in the mandible of Skhūl V. The right lower Pm–1 was probably lost from an abscess at its root, which has exposed almost the entire root of the neighbouring premolar. The crown of the right lower M–1 is deeply worn, especially on its buccal margin, and the roots on the buccal aspect are separated from the alveolus either by the formation of an abscess or the impaction of food. The alveolar margins are low and the roots of the teeth exposed more than is normal; this may be due to pyorrhea.

The crowns of the front teeth are worn flat in both the Tabūn jaws, like those in the Heidelberg mandible. In both, the incisor bite had been edge to edge. The crowns of the canine teeth in the old woman (Skhūl II) are worn more on the lingual than on their buccal margins. The first molars of Skhūl IV and V are worn so as to expose the dentine on the whole of the chewing surface, the wear being greatest on their buccal side. There is no instance of the crowns of the teeth being worn completely away so that only necks and roots were left, as in the dentition of the Gibraltar woman.

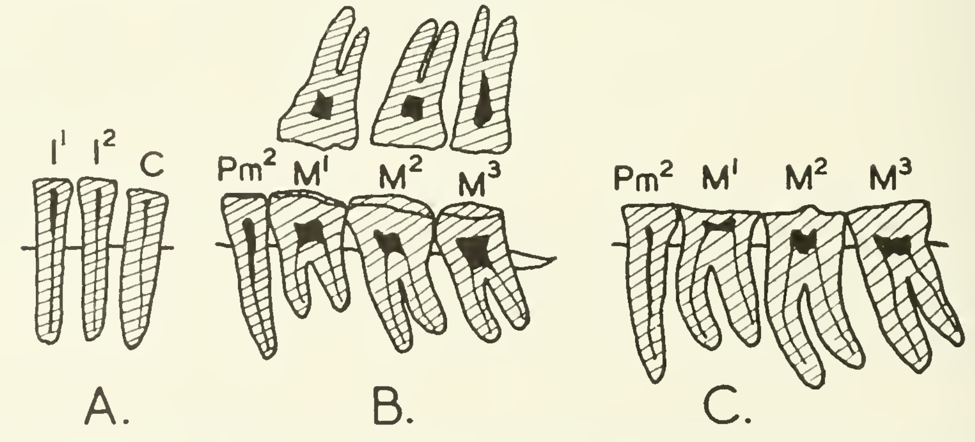


FIG. 132. TRACINGS MADE FROM SKIAGRAMS. A, Tabūn I, lower left I–1, I–2 and Canine; B, Tabūn I, upper left M–1, M–2, M–3; lower left Pm–2, M–1, M–2, M–3; C, Tabūn II, lower left Pm–2, M–1, M–2, M–3. (Nat. size.)

DENTITION

Table LXIV. TABŪN SERIES I–IV (MISCELLANEOUS)

	Series I						*Series II*				
	$\underline{I-2}$	$\underline{C}$	$\underline{Pm-1}$	$\underline{Pm-2}$	$\underline{M-1}$	$\underline{M-2}$	$\underline{I-2}$	$\overline{I-2}$	$\underline{Pm-1}$	$\underline{M-1}$	$\underline{M-1}$
	R	R	R	R	R	R	L	R	R	R	L
Crown:											
medio-distal diam.*	7·4	8·2	7·4	7·2	11·2	10·1	8·1	7·2	(8·4)	11·8	..
labio-lingual diam.†	7·8	8·9	10·1	9·7	11·3	(11·4)	8·8	9·0	10·5	(12·3)	(13·1)
Neck:											
medio-distal diam.	5·2	6·1	5·3	5·1	8·0	..	6·4	6·2	..	..	..
labio-lingual diam.	7·3	8·3	9·0	8·6	10·7	10·7	8·5	..	..	..	..
Crown height‡	10·3	11·5	8·7	7·3	6·9	6·4	12·8	11·5	8·1	8·1	9·3
Root length§	16·2	..	(12·7)	..	13·4	..	..	..	..	..	..
Total tooth length‖	25·1	..	..	..	19·7	..	..	..	..	..	..

	Series III					*Series IV*			
	$\underline{I-1}$	$\underline{I-2}$	$\overline{M-1}$	$\overline{M-3}$	$\overline{M-1}$¶	$\underline{i-1}$	$\underline{m-2}$	$\underline{m-2}$	$\overline{m-2}$
	L	L	L	R	R	R	L	R	L
Crown:									
medio-distal diam.	9·2	7·4	12·3	11·1	10·8	9·1	9·0	9·2	11·2
labio-lingual diam.	8·2	7·9	11·5	9·7	10·0	5·9	10·6	10·7	(9·4)
Neck:									
medio-distal diam.	6·5	5·3	10·5	9·3	8·9	5·5	6·6	7·0	9·3
labio-lingual diam.	7·3	7·2	10·5	8·8	8·7	4·9	9·6	9·6	(8·9)
Crown height	10·0	10·0	8·1	4·5	5·4	7·4	5·0	5·5	4·8
Root length	17·0	..	..	..	..	..	9·9	..	..
Total tooth length	25·8	..	..	..	..	..	14·6	..	..

* Medio-distal diameter of crown, measured between the points or areas of interdental contact except in the case of the Canine and Pm–1 where the maximum diameter is taken.

† Labio-lingual diameter of crown, taken at right angles to the medio-distal diameter.

‡ Crown height: the projected height taken on the buccal aspect from the lower margin of the enamel to the highest point of the occlusal surface.

§ Root length: measured from the lower margin of the neck to the tip of the most distant root, except in the molars where the length is taken from the point of bifurcation of the roots to the most distant root tip.

‖ Total tooth length: maximum length of crown and root.

¶ Tabūn E*b* (Acheulean).

Table LXV. TABŪN COMPLETE DENTITIONS*

TABŪN I—MAXILLA

	I–1	*I–2*	*C*	*Pm–1*	*Pm–2*	*M–1*	*M–2*	*M–3*
	R	L	R	R	R	L	R	L
Crown:								
medio-distal diam.	9·0	7·3	7·9	7·5	6·5	10·8	10·5	8·3
labio-lingual diam.	8·2	7·7	8·8	9·8	9·6	11·5	11·7	10·2
Crown height	6·3	6·0	6·8	7·0	6·2	5·8	6·3	6·7
Total tooth length	23·3	23·0	30·6	(21·0)	(18·5)	(17·0)	(19·6)	19·0

TABŪN I—MANDIBLE

	R	R	R	R	R	R	R	L
Crown:								
medio-distal diam.	5·7	6·7	8·0	7·0	5·9	10·0	11·2	10·9
labio-lingual diam.	7·0	7·6	8·3	8·5	8·7	10·5	10·6	9·8
Crown height	5·0	6·0	6·3	5·7	5·7	4·6	4·8	4·7
Total tooth length	(21·0)	(23·0)	(27·0)	..	(20·0)	(16·6)	(20·3)	(19·4)

TABŪN II—MANDIBLE

	R	R	R	R	R	R	R	R
Crown:								
medio-distal diam.	5·9	6·1	8·0	7·8	7·9	11·0	10·8	11·5
labio-lingual diam.	8·0	8·2	9·0	9·0	9·5	11·0	11·0	10·8
Crown height	..	..	..	..	..	..	..	..
Total tooth length	(23·2)	(24·2)	(27·2)	(23·0)	(24·0)	(19·0)	(24·7)	(23·0)

* The measurements given are for teeth of the right side, save where an exception is noted due to the left specimen being the more complete. Figures in brackets representing total tooth length are from measurements of skiagrams.

Table LXVI. PALATAL AND MANDIBULAR AREAS

	Tabūn I	*Bush-man*	*Tabūn I*	*Bush-man*	*Krapina H*	*Spy I*	*Tabūn II*	*Krapina I*	*Heidel-berg*	*Gibraltar*
	(max.)	(max.)	(mand.)	(mand.)	(mand.)	(mand.)	(mand.)	(mand.)	(mand.)	(max.)
Dental arch:										
area (in sq. cm.)*	32·9	29·1	31·1	27·0	30·9	30·0	32·7	30·7	34·6	31·6
ant.-post. diam.†	55·5	55·4	54·0	55·0	58·0	54·0	59·0	54·5	60·0	54·0
Bimolar diam.:										
M-2–M-2‡	69·3	65·2	66·4	60·0	64·5	68·0	66·2	72·0	68·0	67·0
M-1–M-1	67·0	63·0	62·5	55·0	59·0	65·0	60·5	62·5	62·0	..
Ratio of antero-post. diam. of arch to bi-molar (M-2) diam.	124·8	117·7	122·9	109·0	111·2	125·9	112·2	132·1	113·3	124·0
Bi-canine diam.	48·0	40·0	38·0	31·3	37·0	36·0	37·3	34·0	36·2	43·5
Sum of M-D diams. of teeth	67·8	67·7	65·4	63·9	72·0	59·0	69·0	66·2	73·5	..
Molar teeth:										
mean M-D diam.	9·8	9·8	10·7	11·0	12·4	10·3	11·1	11·1	12·4	..
mean L-L diam.	11·1	11·1	10·3	10·7	10·9	10·5	10·9	10·4	11·6	..
Ratio of means§	113·2	113·2	96·2	97·2	87·9	101·9	98·2	93·7	93·5	..

* Dental area: for method of computation, cf. pp. 195, 197.
† Figs. 130, 131, line O–O.
‡ Bimolar diameter: measured between the most distant points on the buccal surfaces.
§ Ratio of the mean L–L to the mean M–D diameter.

Table LXVII. PALATAL AND MANDIBULAR AREAS

	Skhūl IV		*Skhūl V*		*Australian*	
	(max.)	(mand.)	(max.)	(mand.)	(max.)	(mand.)
Dental arch:						
area (in sq. cm.)	35·4	30·3	36·3	36·2	34·6	33·2
antero-post. diam.	58·5	53·0	61·0	62·0	61·0	61·0
Bi-molar diam.:						
M-2–M-2	75·5	(71·0)	71·0	69·0	69·0	66·0
M-1–M-1	70·5	(64·0)	68·0	63·0	66·0	58·0
Ratio of antero-post. diam. of arch to bi-molar (M-2) diam.	129·0	133·9	116·4	101·6	113·1	108·2
Bi-canine diam.	46·4	(36·0)	46·4	41·3	46·0	36·0
Bi-premolar (Pm-1) diam.	55·0	(46·0)	57·4	(52·0)	54·0	44·0
Sum of M-D diams. of teeth	70·3	65·5	68·3	69·4	70·7	70·7
Molar teeth:						
mean M-D diam.	10·1	10·9	10·3	11·4	10·7	12·3
mean L-L diam.	11·9	10·6	12·2	11·2	13·0	12·3
Ratio of means	117·8	97·2	118·4	98·2	121·5	100·0

Table LXVIII. SKHŪL TEETH

SKHŪL I

	$\underline{i-1}$	$\underline{c}$	$\underline{m-1}$	$\underline{m-2}$	$\overline{i-2}$	$\overline{c}$	$\overline{m-1}$	$\overline{m-2}$	$\underline{I-1}$	$\underline{I-2}$	$\underline{C}$	$\underline{M-1}$	$\overline{M-1}$
	L	L	R	R	L	R	R	R	R	R	L	R	R
Crown diameters:													
medio-lateral*	8·5	7·0	8·9	9·8	5·5	7·0	9·5	10·6	10·9	8·8	8·7	12·4	11·6
labio-lingual	5·3	4·9	8·6	10·0	5·0	5·7	7·5	9·1	8·7	6·2	8·0	11·3	10·5
Crown height	6·5	8·4	8·3	5·9	6·0	7·2	5·7	5·8	8·7	8·0	8·2	7·0	7·0
Root length	..	8·0	7·0	..	..	5·4	..	..	..	..	..	..	..
Total tooth length	..	16·4	12·5	..	..	12·6	..	..	..	..	..	..	..

SKHŪL X

	$\overline{i-1}$	$\overline{i-2}$	$\overline{m-1}$	$\overline{m-2}$	$\underline{Pm-1}$	$\underline{M-1}$	$\underline{M-2}$	$\overline{I-1}$	$\overline{I-2}$	$\overline{C}$	$\overline{M-1}$
	L	R	L	L	R	L	R	L	R	L	L
Crown diameters:											
medio-lateral	5·0	(5·0)	(12·5)	11·0	8·7	12·0	12·2	6·5	7·2	9·1	(13·0)
labio-lingual	4·3	4·8	(10·0)	9·2	10·5	12·5	12·0	7·7	8·0	(7·0)	11·2
Crown height	5·2	..	7·2	5·8	8·5	8·0	9·5	10·5	10·0	12·0	9·0
Root length	..	..	..	..	..	..	..	..	..	..	..
Total tooth length	12·5	..	..	..	..	..	..	..	..	..	..

SKHŪL II

	$\underline{C}$	$\underline{Pm-2}$	$\underline{M-1}$	$\underline{M-2}$	$\overline{I-1}$	$\overline{C}$	$\overline{C}$	$\overline{Pm-1}$	$\overline{Pm-2}$	$\underline{M-2}$
	R	R	R	R	L	L	R	L	L	L
Crown diameters:										
medio-lateral	7·5	7·0	9·9	9·6	4·5	6·9	6·4	5·8	7·2	11·3
labio-lingual	9·0	11·0	11·7	11·5	7·0	8·4	8·2	7·7	8·6	10·0
Crown height	4·5	3·2	6·0	4·6	4·5	5·7	5·5	4·4	4·5	4·7
Root length	(15·0)	13·4	6·7	5·5	13·5	15·0	14·5	13·7	13·4	9·5
Total tooth length	(20·0)	16·2	17·7	16·0	18·0	20·0	20·0	18·6	18·0	18·5

SKHŪL VII

	$\underline{I-1}$	$\underline{I-2}$	$\underline{M-1}$	$\underline{M-2}$	$\underline{M-3}$	$\underline{M-2}$	$\underline{M-3}$	$\overline{M-1}$	$\overline{M-2}$	$\overline{M-3}$	$\overline{M-1}$	$\overline{M-2}$	$\overline{M-3}$
	L	L	R	R	R	L	L	R	R	R	L	L	L
Crown diameters:													
medio-lateral	9·2	6·8	10·7	8·6	9·0	9·0	8·6	..	9·5	10·7	10·5	(10·0)	10·3
labio-lingual	8·2	8·0	11·2	12·0	11·4	12·3	11·0	..	(10·5)	10·1	..	(11·0)	10·1
Crown height	6·0	7·0	5·0	5·3	5·0	5·4	5·3	..	4·5	(4·0)	2·5	3·4	3·0
Root length	16·4	(18·5)	(8·0)	..	..	(11·0)	12·0	..	..	..	..	..	..
Total tooth length	22·5	(23·5)	19·4	(19·0)	(17·0)	21·5	(20·0)	(16·5)	(20·5)	(18·5)	16·0	(19·5)	(17·0)

* Taken between the points of interdental contact except in the case of the canine and the Pm–1, where the maximum medio-distal diameter is taken.

Table LXVIII (cont.). SKHŪL TEETH

SKHŪL IV

	$\underline{I-1}$	$\underline{I-2}$	$\underline{C}$	$\underline{Pm-1}$	$\underline{Pm-2}$	$\underline{M-1}$	$\underline{M-2}$	$\underline{M-3}$	$\overline{I-1}$	$\overline{I-2}$	$\overline{C}$	$\overline{Pm-1}$	$\overline{Pm-2}$	$\overline{M-1}$	$\overline{M-2}$	$\overline{M-3}$
Crown diameters:	R	L	R	R	L	R	R	R	L	R	R	R	R	R	R	R
medio-distal	10·0	6·2	8·9	7·4	7·5	11·0	9·9	9·4	4·8	6·0	7·3	7·2	7·6	11·5	10·5	10·6
labio-lingual	8·2	7·2	8·5	10·0	8·4	12·5	12·2	11·1	6·5	7·1	8·0	8·0	8·3	11·2	10·7	9·9
Crown height	6·3	4·8	6·2	5·2	5·0	7·3	5·6	6·0	4·5	7·0	9·5	5·2	4·0	3·5	4·0	3·8
Root length .	..	..	..	..	..	10·0	7·5	6·0	..	..	..	..	..	7·0	9·0	(10·0)
Total tooth length .	26·3	23·0	(29·0)	(24·5)	(22·5)	(21·0)	(19·2)	(17·0)	(19·0)	..	(25·5)	(19·5)	..	(17·0)	(18·0)	(19·0)

SKHŪL V

	$\underline{I-1}$	$\underline{I-2}$	$\underline{C}$	$\underline{Pm-1}$	$\underline{Pm-2}$	$\underline{M-1}$	$\underline{M-2}$	$\underline{M-3}$	$\overline{I-1}$	$\overline{I-2}$	$\overline{C}$	$\overline{Pm-1}$	$\overline{Pm-2}$	$\overline{M-1}$	$\overline{M-2}$	$\overline{M-3}$
Crown diameters:	R	R	R	R	R	R	R	R	L	R	R	L	R	R	R	R
medio-distal	8·5	7·0	8·7	8·2	7·0	11·0	10·8	9·1	5·0	6·4	8·0	8·2	7·7	11·3	11·6	11·4
labio-lingual	7·5	7·2	9·5	10·8	10·8	12·5	12·2	11·8	6·4	7·0	9·0	9·2	9·1	11·5	11·4	10·5
Crown height	7·5	5·2	7·2	7·0	6·2	6·2	6·5	4·5	6·2	7·6	8·4	4·4	4·7	4·0	4·7	4·0
Root length .	..	..	..	..	..	10·0	9·0	7·3	..	..	..	..	..	11·0	8·5	10·0
Total tooth length .	(23·0)	(23·0)	(24·7)	(18·6)	(19·5)	(19·0)	(17·0)	(15·5)	(19·5)	(21·5)	(26·0)	(19·5)	(19·5)	(18·0)	(16·5)	(17·0)

SKHŪL VI

	$\underline{C}$	$\underline{M-1}$	$\overline{Pm-1}$	$\overline{M-3}$
	L	R	L	L
Crown diameters:				
medio-distal . .	8·0	11·5	12·2	12·2
labio-lingual . .	9·6	12·2	11·0	10·4
Crown height . .	6·8	4·5	5·4	7·0
Root length . . .	..	..	..	..
Total tooth length	(26·0)	(21·0)	..	(21·0)

Table LXIX. MEAN MEASUREMENTS OF PERMANENT INCISORS AND CANINES

	Tabūn	*Skhūl*	*Krapina**	*Australians†*	*Miscellaneous‡*	*Chimpanzee*
			Upper medial incisor			
Crown diameters:	(2)	(4)				
medio-distal	9·1	9·6	10·4	9·4	8·9	11·7
labio-lingual	8·2	8·2	9·1	7·9	7·1	9·1
index	90·0	85·4	87·5	84·3	80·0	77·7
			Upper lateral incisor			
Crown diameters:	(4)	(4)				
medio-distal	7·5	7·2	8·4	7·6	7·0	8·3
labio-lingual	8·1	7·15	9·1	6·9	6·7	8·4
index	108·0	99·3	108·3	92·0	95·7	101·0
			Upper Canine			
Crown diameters:	(2)	(5)				
medio-distal	8·1	8·4	9·5	8·4	7·9	11·0
labio-lingual	8·8	8·9	10·3	9·0	8·3	9·5
index	108·6	105·9	108·3	107·1	105·0	86·3
			Lower medial incisor			
Crown diameters:	(2)	(4)				
medio-distal	5·8	5·2	6·2	6·0	5·0	7·5
labio-lingual	7·5	6·9	8·1	6·3	5·7	7·5
index	129·3	132·7	130·6	105·0	114·0	100·0
			Lower lateral incisor			
Crown diameters:	(3)	(3)				
medio-distal	6·7	6·5	7·5	6·7	5·8	8·0
labio-lingual	8·3	7·4	8·2	6·6	6·1	8·0
index	124·0	114·0	109·3	98·5	105·1	100·0
			Lower Canine			
Crown diameters:	(2)	(5)				
medio-distal	8·0	7·5	8·1	7·6	7·0	9·8
labio-lingual	8·6	8·1	9·6	8·3	7·9	10·5
index	107·5	108·0	118·3	109·2	113·0	106·0

Figures in brackets indicate the number of specimens.
* Means calculated from individual measurements given by Kramberger (1906).
† Means taken from Campbell (1925).
‡ Means from measurements of the teeth of three male skulls, English, Bushman, Australian.

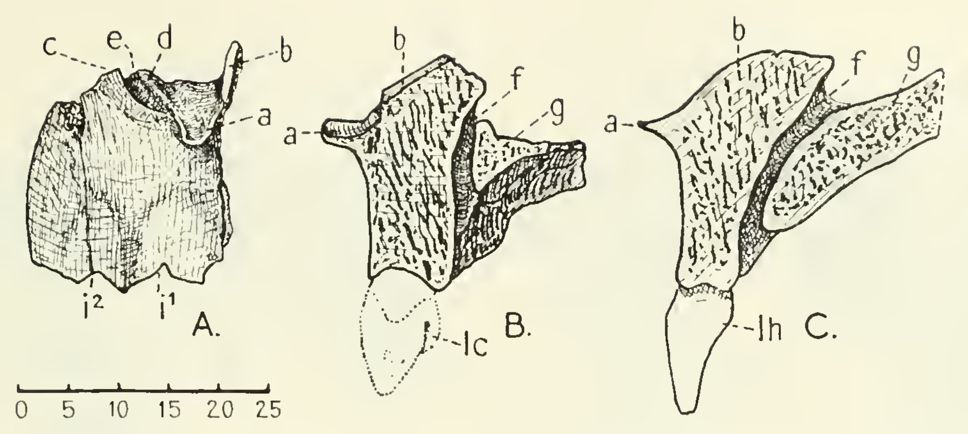


Fig. 120. Fragment of the Right Maxilla of a boy about Ten Years of Age, Tabūn Series I, Layer B. A, anterior view; B, medial view; C, Medial view of an English maxilla (of a youth of about 15 years, the dentition being complete except for the third molars). *a*, nasal spine; *b*, septal process of the premaxilla (covered in A and B by a separate narrow lamella of bone); *c*, lateral margin of nasal aperture; *d*, paraseptal ridge of aperture; *e*, marginal fossa; *f*, upper end of naso-palatine canal; *g*, palatal process; *lc*, lingual cusp (on a slightly worn median incisor belonging to an older individual than that represented by the maxillary fragment); *lh*, lingual heel of a normal modern incisor; i–1, i–2, alveoli for the upper incisors.

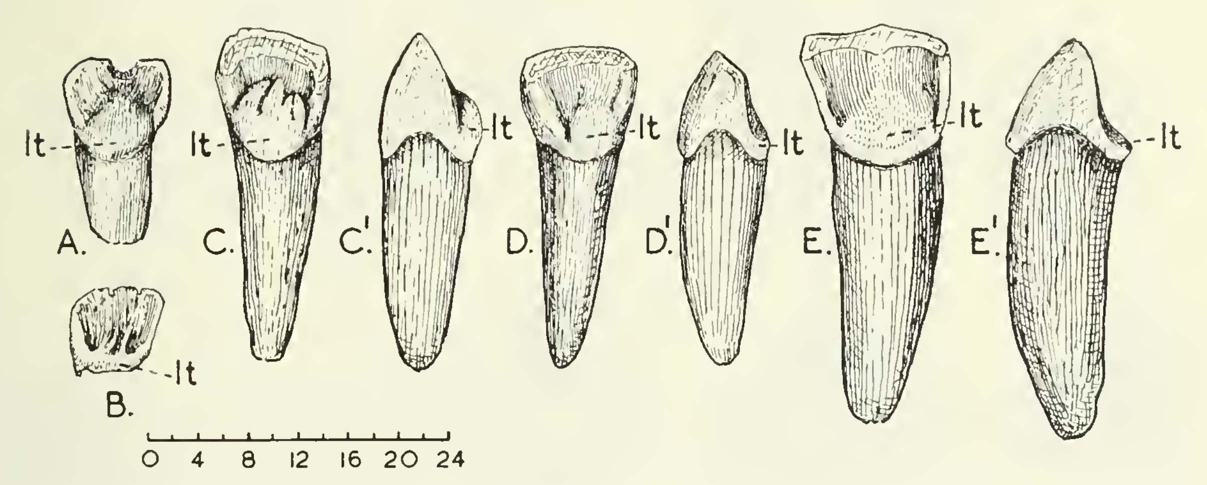


Fig. 121. Upper Medial Incisors. A, Tabūn Series IV, right i–1, lingual aspect; B, Krapina, right i–1, lingual aspect (after Kramberger); C, Tabūn Series III, left I–1, lingual aspect and C′, medial aspect; D, Australian male, left I–1, lingual aspect and D′, medial aspect; E, Chimpanzee, left I–1, lingual aspect and E′, medial aspect. *lt*, lingual tubercle.

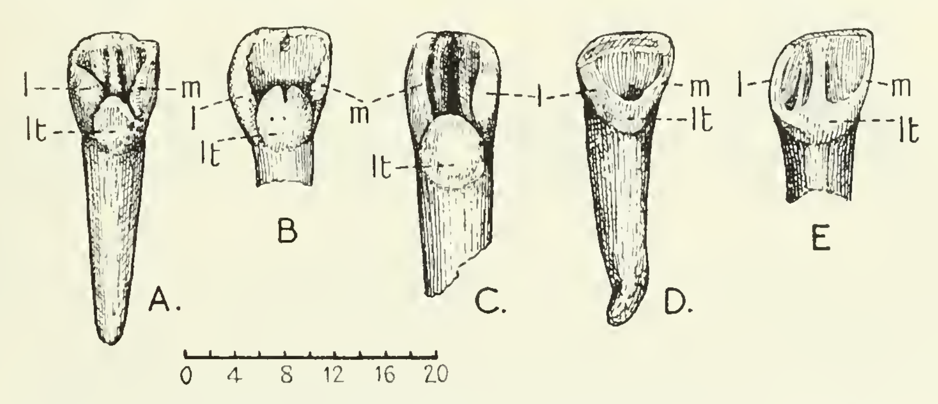


Fig. 122. Lingual Aspect of the Upper Lateral Incisor. A, Tabūn Series I, right I–2; B, Krapina, right I–2 (after Kramberger); C, Tabūn Series III, left I–2; D, Australian male, right I–2; E, Chimpanzee, right I–2. *lt*, lingual tubercle; *m*, medial marginal fold; *l*, lateral marginal fold.

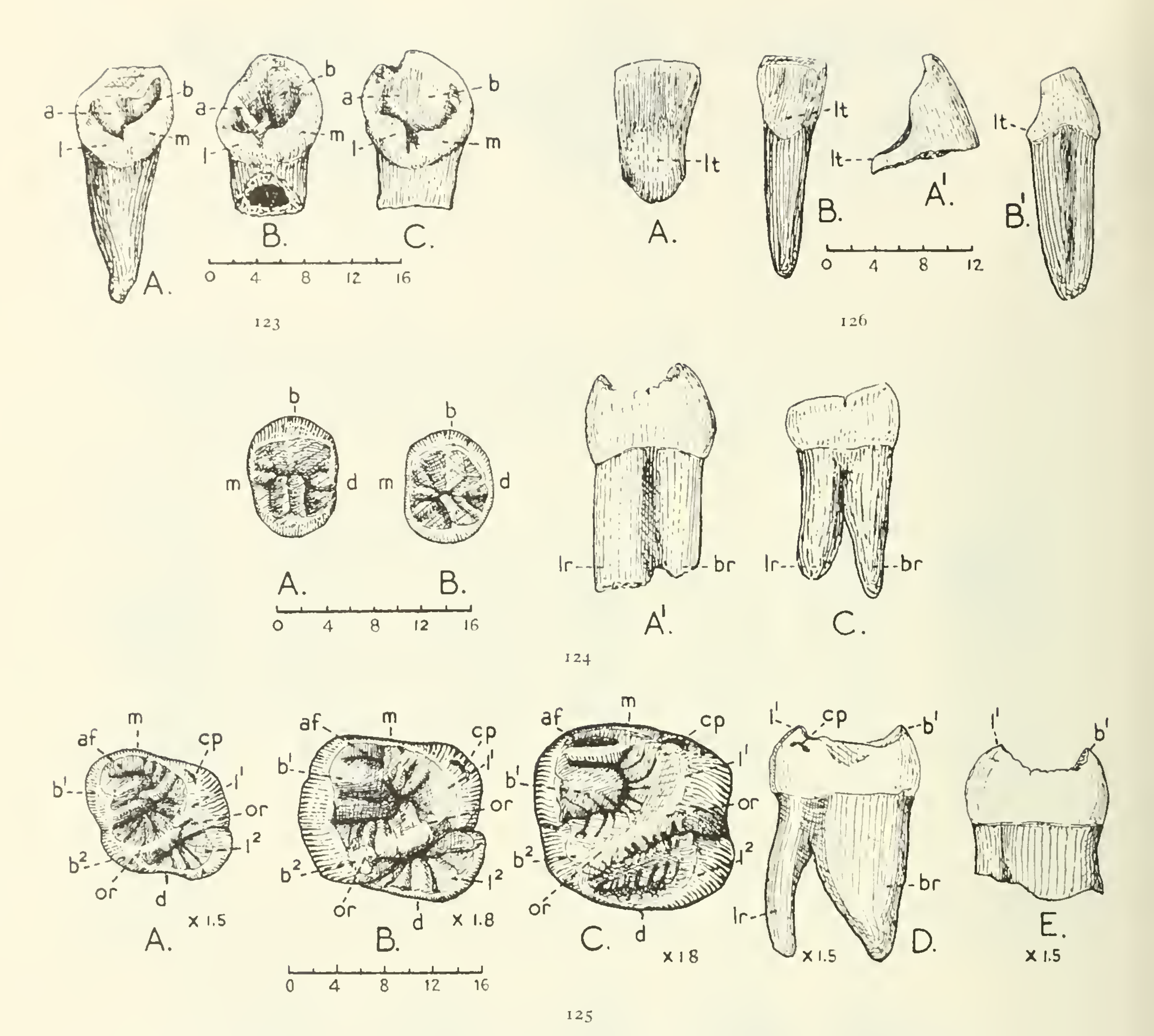


FIG. 123. LINGUAL ASPECT OF THE UPPER RIGHT CANINE. A, Bushman; B, Tabūn Series I; C, Krapina (after Kramberger). *a*, *b*, ridges on main cusp; *l*, lateral fold of cingulum; *m*, medial fold of cingulum.

FIG. 124. UPPER PREMOLARS. A, Tabūn Series I, right Pm–1, occlusal aspect; B, Tabūn Series I, right Pm–2, occlusal aspect; A′, medial aspect of A; D, Bushman, medial aspect of right Pm–2. *b*, buccal margin of crown; *d*, distal margin of crown; *m*, medial margin of crown; *br*, buccal root; *lr*, lingual root. The division of the root in A′ is indicated only by a groove.

FIG. 125. THE UPPER MOLARS. A, Tabūn Series I, right M–2, occlusal aspect (× 1.5); B, Le Moustier, right M–2, occlusal aspect (× 1.8); C, Dryopithecus rhenanus, right M–2, occlusal aspect (× 1.8) (after Gregory); D, Tabūn Series I, right M–1, medial aspect (× 1.5); E, Tabūn Series I, right M–2, medial aspect (incompletely erupted (× 1.5); b^1, first buccal cusp (paracone); b^2, second buccal cusp (metacone); l^1, first lingual cusp (protocone); l^2, second lingual cusp (hypocone); *af*, anterior fovea; *cp*, Carabelli pit in the enamel; *d*, distal margin; *m*, medial margin; *or*, oblique ridge; *br*, buccal root (medial); *lr*, lingual root.

FIG. 126. THE LOWER RIGHT LATERAL INCISOR. A, Tabūn Series II, lingual aspect, and A′, distal aspect: B, Bushman male, lingual aspect, and B′, distal aspect. Only the crown of the fossil tooth is preserved. *lt*, lingual tubercle.

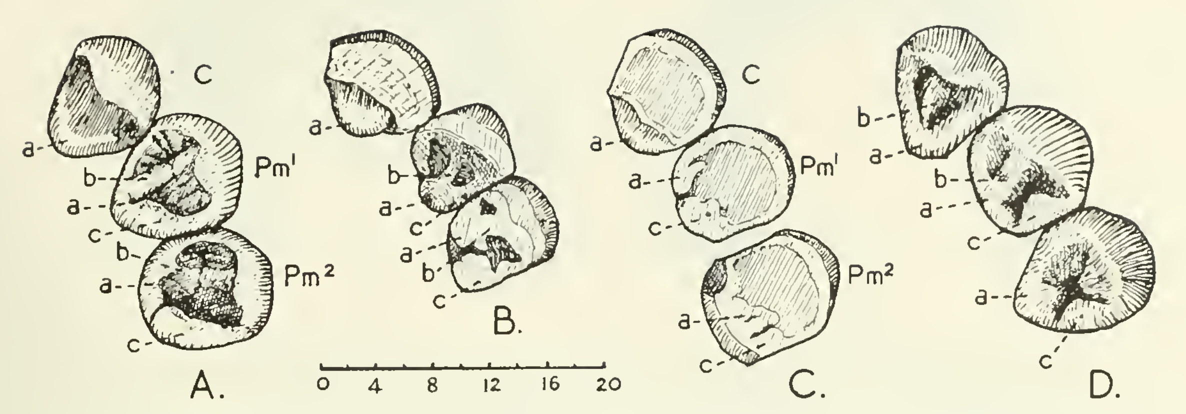


Fig. 127. The Lower Right Canine and Premolar Teeth, Occlusal Aspect. A, American Indian (after Gregory); B, Tabūn I (female); C, Tabūn II (male); D, Le Moustier. *a*, lingual tuberosity or cusp; *b*, chief ridge of lingual cusp; *c*, distal cingular fold, representing the talonid of the lower molars.

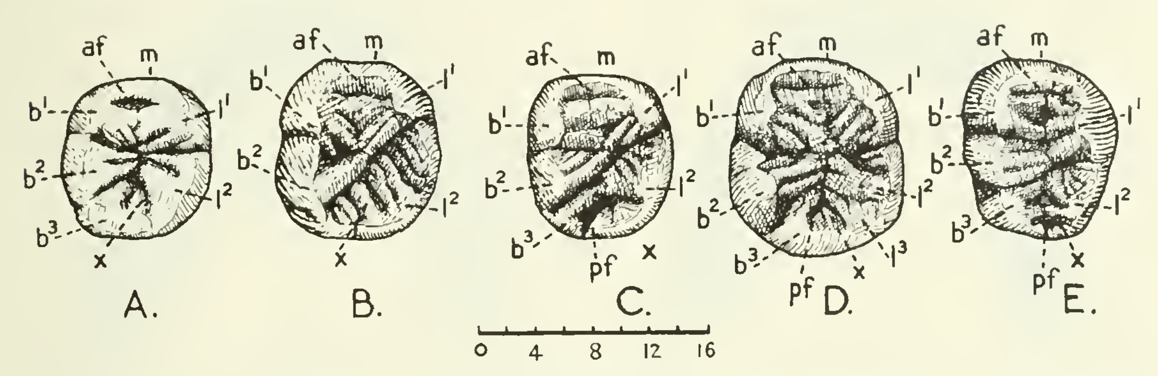


Fig. 128. Occlusal Aspect of the Lower Molars to show the Cusp and Ridge Pattern. A, Bushman, left M–2 (somewhat worn and depicting a condition common in the molars of living native races); B, Tabūn Series III, left M–1; C, Le Moustier, left M–2; D, Krapina, left M–1; E, Dryopithecus rhenanus, left M–1 (after Gregory). b^1, first buccal cusp (protoconid); b^2, second buccal cusp (hypoconid); b^3, third buccal cusp (hypoconulid); l^1, first lingual cusp (metaconid); l^2, second lingual cusp (entoconid); l^3, third lingual cusp; *af*, anterior fovea; *pf*, posterior fovea; *m*, medial margin; *x*, distal marginal ridges.

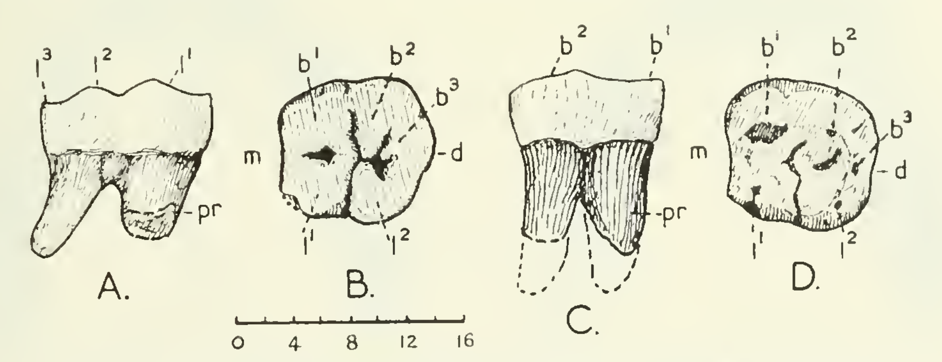


Fig. 129. Lower Molar Teeth, Various. A, Tabūn Series IV, left M–2, lingual aspect; B, Tabūn Series III, right M–3, occlusal aspect; C, Tabūn E*b* (Acheulean), right M–1 (?), buccal aspect, and D, occlusal aspect of same. b^1, b^2, b^3, l^1, l^2 (cf. Fig. 128); *d*, distal margin; *m*, medial margin; *pr*, proximal root.

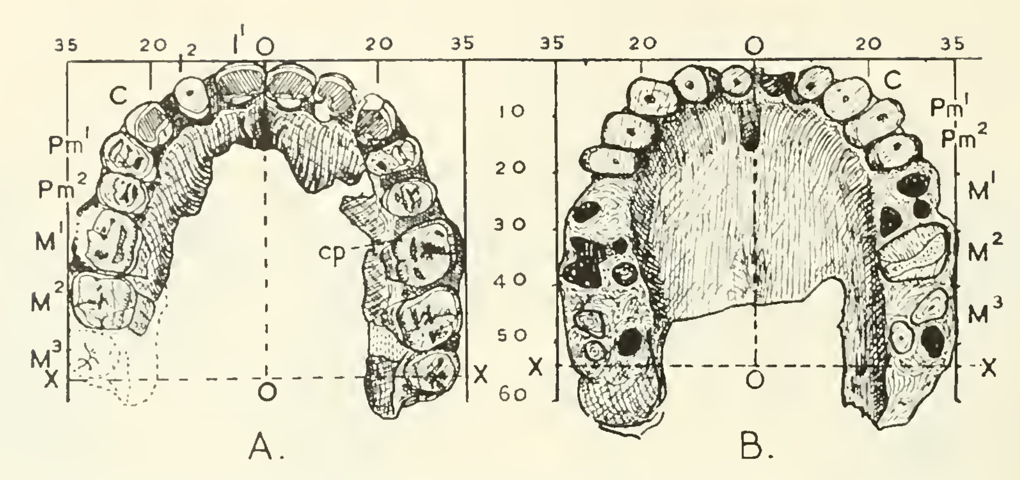


FIG. 130. THE DENTAL PALATE. A, Tabūn I; B, Gibraltar. *O–O*, midline of the palate; *X–X*, line bounding the palate and tangent to the M–3's. Both specimens are orientated within a frame 70 mm. wide and enclosed posteriorly by the line *X–X*. The area of the palate is bounded by the buccal margins of the teeth and the line *X–X*. In the Tabūn specimen the left side is somewhat distorted and the right side has been chosen as the more normal of the two; the right M–3 is lacking and the stippled outline is that of the left M–3, reversed. *cp*, Carabelli pit.

FIG. 131. LOWER DENTITION. A, Tabūn I; B, Krapina H (after Kramberger); C, Tabūn II; D, Krapina I (after Kramberger). Viewed at right angles to the alveolar plane of the mandible and set within a frame 70 mm. wide and bounded anteriorly by the pre-incisor plane drawn tangent to the buccal margin of the median incisors and posteriorly by the post-molar plane (*X–X*). *O–O* midline of the palate; *gt*, area for origin of the lingual muscles.

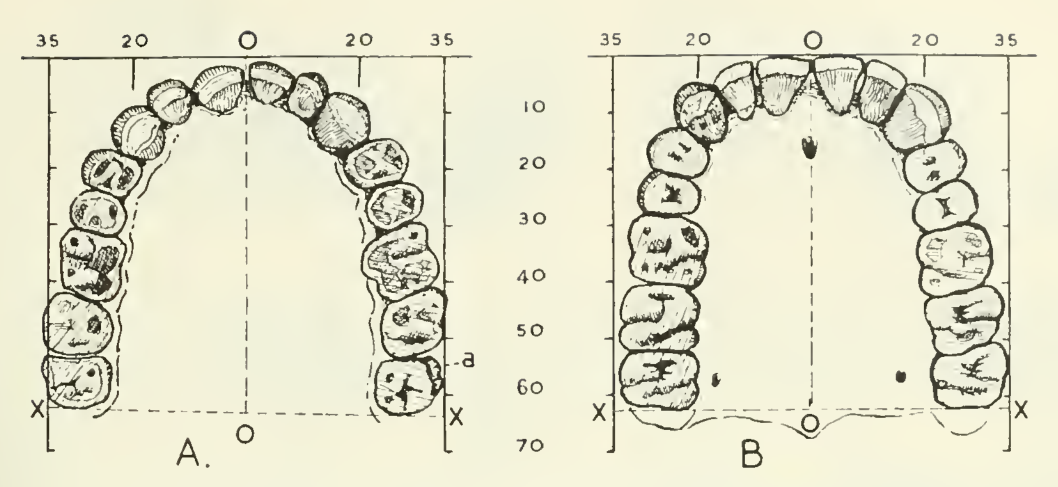


FIG. 133. DENTAL PALATE. A, Skhūl V; B, Australian male. *a*, extra cuspule on the left M–3. Presented in the same way as are the specimens in Fig. 130.

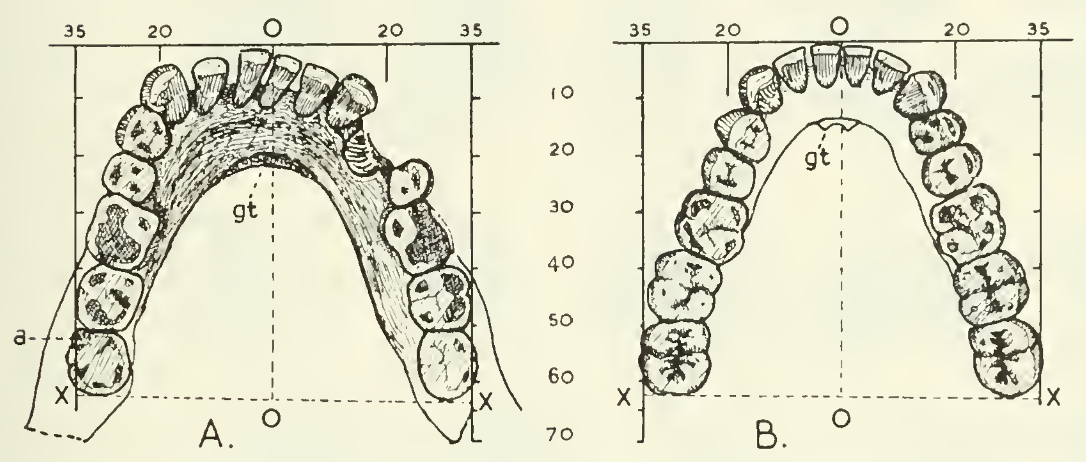


FIG. 134. LOWER DENTITION. A, Skhūl V; B, Australian male. *a*, depressed unworn area corresponding to the abnormal cusp shown in Fig. 133 A, *a*. *gt*, area for the attachment of the genio-glossus muscle. Represented as are the specimens shown in Fig. 131.

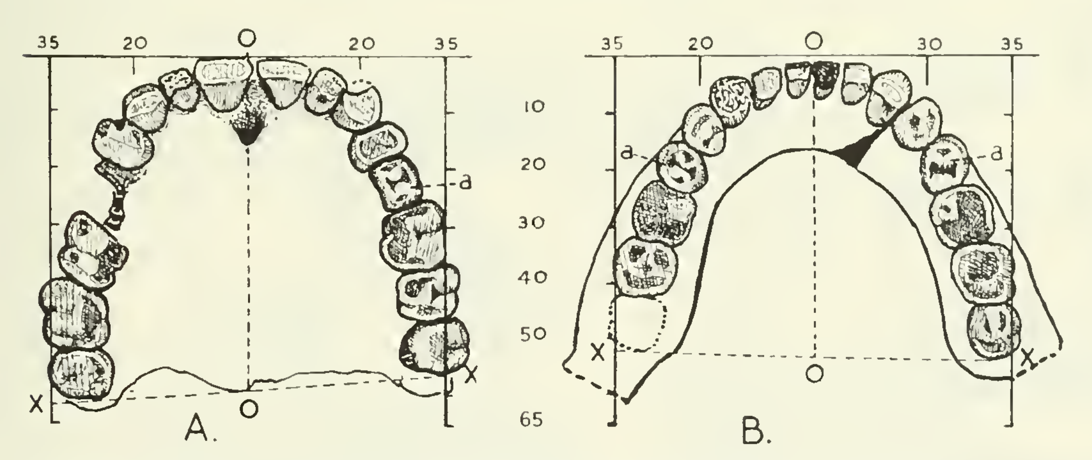


FIG. 135. UPPER AND LOWER DENTITIONS OF SKHŪL IV. A, Dental palate; B, Mandibular arch. *a*, the second premolars are malposed, having erupted so that their proximal surface faces inwards and their distal surface outwards or buccally. Specimens orientated and shown as in Figs. 130, 131.

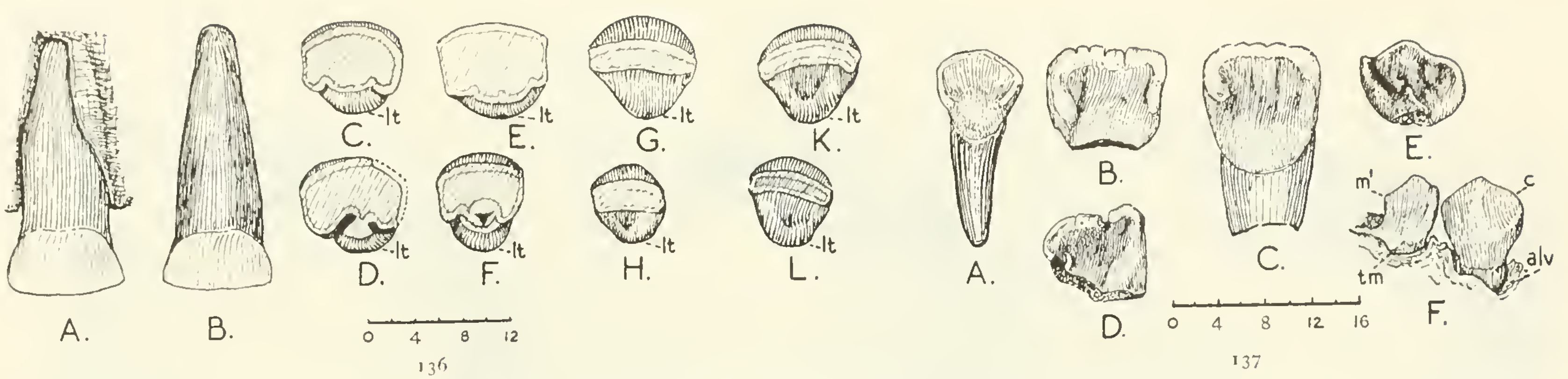


FIG. 136. UPPER INCISOR. A, Tabūn I, left I–1, buccal aspect (drawn within its alveolus); B, Skhūl VII, left I–1, buccal aspect; C, Tabūn I, left I–1, occlusal aspect; D, Tabūn I, left I–2, occlusal aspect; E, Skhūl VII, left I–1, occlusal aspect; F, Skhūl VII, left I–2, occlusal aspect; G, H, Skhūl V, left I–1 and I–2 respectively, occlusal aspect; K, L, Australian male, left I–1 and I–2 respectively, occlusal aspect. *lt*, lingual tuberosity of the crown.

FIG. 137. JUVENILE DENTITION. A, Skhūl I, upper central left milk canine, lingual aspect; B, Skhūl I, crown of the upper right I–1, lingual aspect; C, Tabūn Series IV, crown of the upper right I–1, lingual aspect; D, Skhūl I, crown of the upper right I–2, lingual aspect; E, Skhūl I, crown of the upper left permanent canine, lingual aspect; F, Skhūl I, lower right milk canine with the anterior part of the first milk molar. *alv*, alveolar border of mandible; *tm*, tuberculum molare of m–1.

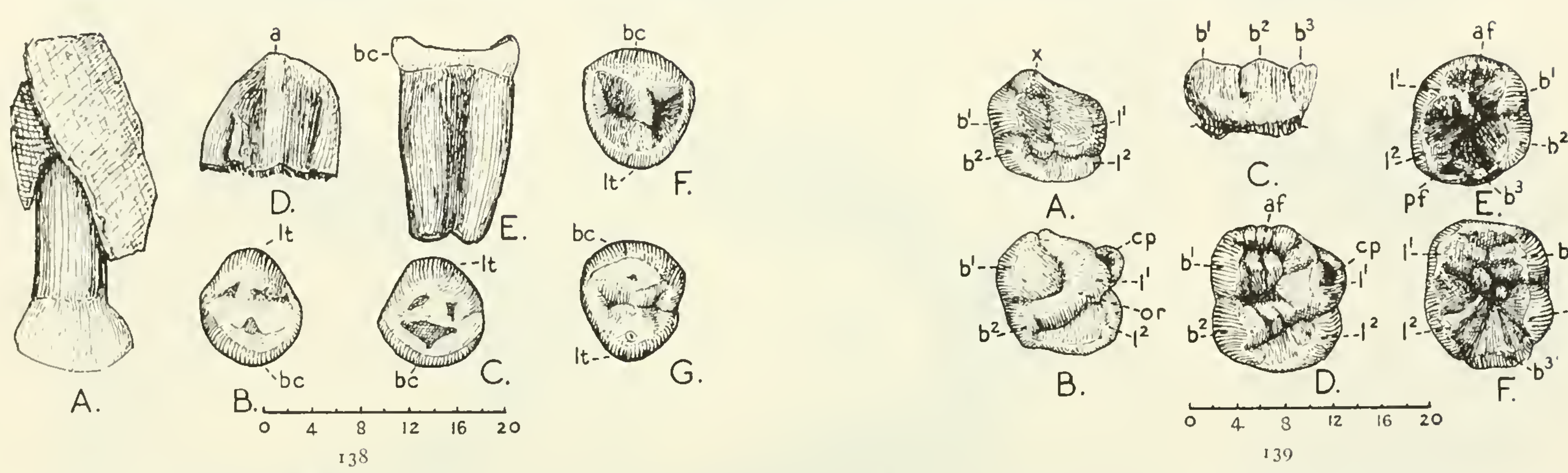


FIG. 138. CANINES AND PREMOLARS. A, Skhūl VI, upper left canine, buccal aspect, still attached to a fragment of the maxilla; B, Skhūl VI, occlusal surface of tooth shown in A; C, Skhūl VI, lower left Pm–1, occlusal surface; D, Skhūl X, the tip of the crown lower left permanent canine, lingual aspect (unerupted); E, Skhūl II, upper right Pm–2, medial aspect, showing a deep groove in the root (crown deeply worn); F, Skhūl X, upper right Pm–1, unerupted, occlusal aspect; G, Tabūn Series V (probably Neanthropic, from Terrace) upper right Pm–1, occlusal aspect. *a*, apex of canine; *lt*, lingual tuberosity; *bc*, buccal cusp.

FIG. 139. SKHŪL I, MOLAR TEETH. A, Skhūl I, upper right m–1, occlusal aspect; B, Skhūl I, upper right m–2, occlusal aspect; C, Skhūl I, lower right m–2, buccal aspect; D, Skhūl I, upper right M–1 (unerupted), occlusal aspect; E, Skhūl I, lower right m–2, occlusal aspect; F, Skhūl I, lower right M–1 (unerupted), occlusal aspect. b^1, b^2, b^3, cusps on the buccal side numbered medio-distally; l^1, l^2, cusps on the lingual side; *af*, anterior fovea; *pf*, posterior fovea; *cp*, Carabelli pit; *x*, paraconule.

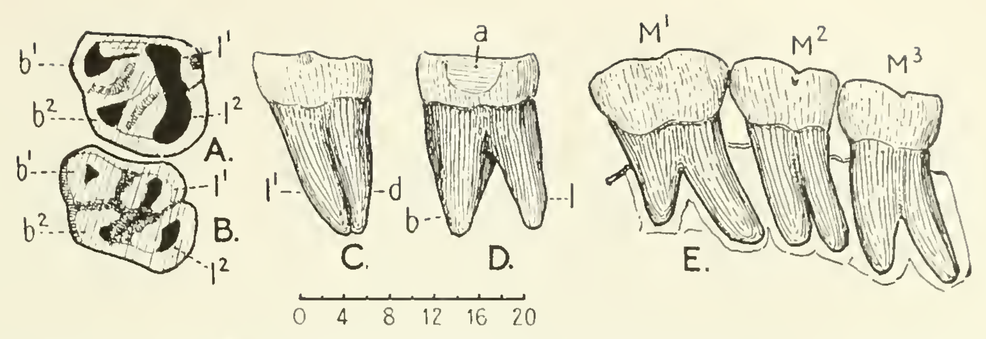


Fig. 140. Skhūl Molar Teeth. A, B, Skhūl VII, upper right M–1 and M–2, occlusal aspect. The dentine exposed at the base of the cusps is shown black; the bottoms of the furrows in the enamel are indicated on the crown surface; b^1, b^2, paracone and metacone; l^1, l^2, protocone and hypocone; C, Skhūl II, upper right M–1, buccal aspect, showing the short stout root; D, Skhūl II, distal aspect of C; E, Skhūl IV, upper right M–1, M–2, M–3, buccal aspect. *a*, inter-dental facet; *d*, distal segment of root; *b*, buccal root; *l*, lingual root.

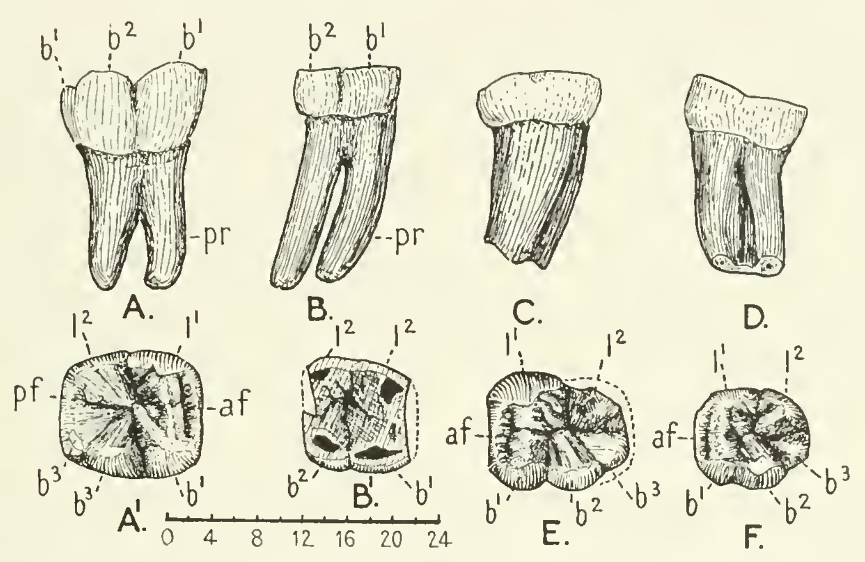


Fig. 141. Molar Teeth. A, Shukbah (Mousterian stratum), lower right M–1, buccal aspect; A′, occlusal aspect of A; B, Mugharet el-Wad (Layer G, Levalloisian) lower right M–2 (?), buccal aspect; B′, occlusal aspect of B; C, Skhūl II, lower right M–2, buccal aspect; D, lingual aspect of C, showing the deep groove separating the roots; E, Skhūl X, lower left M–1 (unerupted crown) occlusal aspect; F, Skhūl X, lower left m–2, occlusal aspect. b^1, b^2, b^3, buccal cusps; l^1, l^2, lingual cusps; *af*, anterior fovea; *pf*, posterior fovea; *pr*, proximal root.

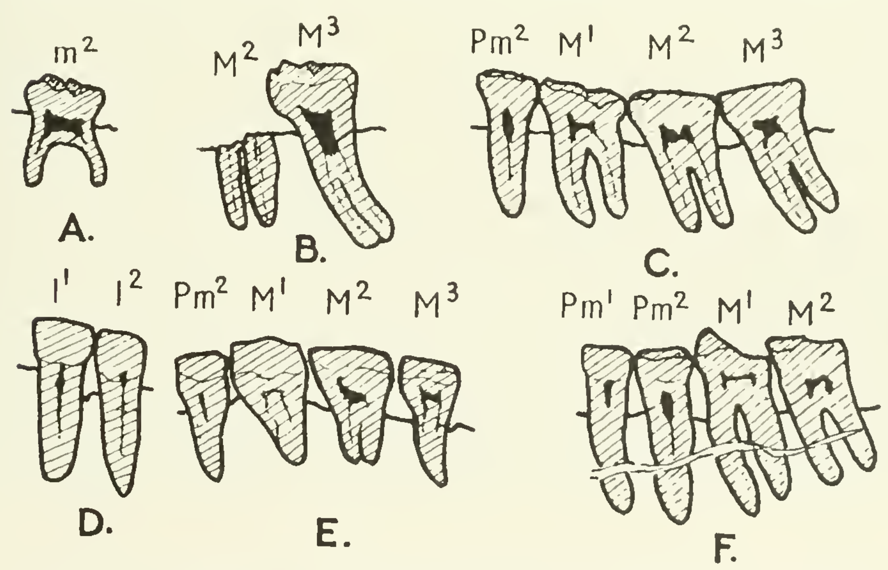


Fig. 142. Tracings from Skiagrams of Skhūl Teeth. A, Skhūl I, lower right m–2; B, Skhūl VI, lower left M–3; C, Skhūl V, lower left Pm–2 and molar teeth; D, Skhūl V, upper left central and lateral incisors; E, Skhūl V, upper right Pm–2 and molar teeth (viewed obliquely); F, Skhūl IV, lower left Pm–1, Pm–2, M–1, M–2 (Pm–2 is malposed and viewed on its distal aspect). (Nat. size.)



CHAPTER XIV

THE MANDIBLE

(Pls. XV, XVI, XXVI, XXVII; Figs. 143–64)

THERE are three almost complete adult mandibles, two from the Tabūn and one from the Skhūl, with the greater part of another Skhūl mandible (Pl. XVI). There is, too, from the latter cave an almost complete mandible of a child, between three and four years of age. The less complete material comprises the symphysis of a child, Skhūl X, between four and five years of age; the symphysial portion of the mandible of a woman (Skhūl II); the greater part of the ascending ramus and part of the corpus of a male (Skhūl VI); various parts, much crushed, of the mandible of a second woman (Skhūl VII).

In this chapter we have restricted ourselves to a discussion of the bony framework of the mandible, all that relates to the teeth and the dental arches having been described in Chapter XIII on the Dentition. First we shall give a description, illustrated by drawings and photographs of each specimen, beginning with those from the Tabūn, which we consider to be more primitive, in an anatomical sense, than those from the neighbouring Skhūl cave. Then we shall proceed to an analysis of the anatomical features of both groups of mandibles, the Tabūn and the Skhūl, and then compare them with lower jaws of other races which may be supposed to be related.

TABŪN I (Pls. XV, XXVI)

A true profile drawing of the mandible of this woman, reproduced three-fifths natural size, a reduction which we shall use for all the mandibles, is given in Fig. 143. The alveolar plane, which we have used throughout, is shown by the line *X–X*. The head and neck of the condyle are a little crushed, but their character is plainly to be seen; they were short and stumpy as in the Heidelberg jaw (Fig. 146). The anterior part of the coronoid is missing on the left side but is partially preserved on the right.

The symphysial region is shaped as in anthropoid apes; there is no chin. We have in mind, when we make this statement, a specific definition of the chin. When the two elements of the symphysial region—the alveolar, which supports and is functionally dominated by the teeth, and the basal, which gives attachment to the lingual muscles—form parts of the same sloping receding plane, then there is no chin. It is when these two elements undergo differential changes that a chin comes into existence. In the Tabūn woman, a chin is as completely absent as in the Heidelberg jaw.

In order that readers may appreciate the points of difference and of agreement between the mandible of Tabūn I and those of modern primitive races, a profile drawing of the mandible of a male Australian is shown in Fig. 144. A reference to Table LXX (p. 229) will show that in their main dimensions and in their indices these two mandibles do not differ greatly. The maximum length, measured from the chin to a vertical plane, which descends behind the condyles, when the bone rests on the mandibulo-metric board, is estimated at 119 mm. in Tabūn II (Fig. 145), at 95 mm. in the Tabūn woman, and 105 mm. in the male Australian. The maximum or bi-condylar widths are: Tabūn I 133 mm.,

Australian 125 mm.; the Tabūn specimen being relatively the wider. If we take the area of the ascending ramus[1] as an index of the development or of the power of the muscles of mastication, then the woman (Tabūn I) comes out as the greater, her area being 18·9 sq. cm. as against 18·2 sq. cm. for the Australian male. The body of the mandible (Table LXXI, p. 229) which has to carry the teeth and transmit the forces engendered in chewing is markedly thicker in Tabūn I, this increase in the labio-lingual diameter compensating for the slightly shallower character of the corpus, as measured from the basal to the alveolar margin.

There is a corresponding system in both mandibles of bony thickenings or bars for transmitting the masticatory forces to and from the teeth. On the lateral aspect of the body of the mandible, immediately in front of the insertion of the masseter muscle, is a great strengthening of the bone, giving rise to an eminence which has been named the lateral prominence (Fig. 144 D, *m*). This is also apparent in the Tabūn mandible (Fig. 143 *m*). From the lateral prominence two bars proceed forward in the body of the mandible, the upper or alveolar (Fig. 144 *o*) to end around the roots of the premolar and molar teeth; the other, the marginal or basal bar (Fig. 144 *n*), proceeds forwards as a thickening of the lower margin where it ends in the alveolar bone around the roots of the front teeth, both incisors and canines. As Weidenreich (1936) has pointed out, a sulcus on the lateral aspect of the mandible (Figs. 143, 144 *s*) separates the marginal from the alveolar bar.

The real difference between the Tabūn I and the modern mandible lies in the region of the symphysis. In a cross-section of the Tabūn symphysis the alveolar or tooth-bearing part continues in the same oblique plane as the lower or basal part to which the muscles of the tongue are attached. In the Australian mandible, as in the mandibles of all modern or Neanthropic races, we see that the basal part of the symphysis has undergone a transformation, being turned forwards so that the alveolar element meets the basal element at an angle, open anteriorly (Fig. 144 C). The forward movement of the basal part of the symphysis extends the floor space of the mouth. In the later evolution of the human races the alveolar and basal elements of the mandible underwent opposite movements, the alveolar a reduction, the basal an increase. This change in the mandible was accompanied by corresponding changes in the tongue, a reduction of the free, licking part so evident in the tongue of a dog, and an increase in the basal muscular elements. The symphysial changes have not begun in the Tabūn mandible; in the Australian mandible they are well under way.

To understand certain changes we are to describe in the other mandibles from Mount Carmel it is necessary to draw attention to some other features revealed by sections of the symphysis shown in Figs. 143 and 144. The alveolar element in the symphysis of Tabūn I is thicker from front to back than is the basal element (Fig. 143, *a*, *a'*); this is also the case in the anthropoid mandible. In the cross-section of the Australian symphysis (Fig. 144 C) the opposite is the case, while in the Bushman the alveolar element has become reduced to a plate, as is the prevailing condition in the mandibles of most modern races (Fig. 144 A). Measurements relating to the symphysis are given in Table LXXI (p. 229); in this table we give separate measurements of the thickness of these two elements of the symphysis, alveolar and basal. The predominance of the alveolar element is still apparent in the Heidelberg jaw, but this specimen, so far as we can learn, is the only other one which

[1] See explanation given in Table LXXII (p. 230) for the method of measurement.

retains this simian feature. We shall see that two other Carmel specimens may have possessed this trait.

We have described two of the changes which have transformed a Tabūn-like symphysis into one bearing a chin. These are (1) a forward movement of the basal element of the symphysis, and (2) a reduction of the alveolar element; besides these two there was a third. It is manifest that with the forward movement of the basal element, the tooth-bearing alveolar portion would remain unsupported. Hence a bony prop or eminence has to be added to the basal region of the symphysis to support the alveolar element and to transmit stresses arising around the roots of the incisors and the canines to the marginal or basal bars of the mandible. This matter we shall discuss later (pp. 220–1). Our Skhūl specimens illustrate all stages in the evolution of a chin. Tabūn I is the single specimen to show a true chinless state.

Another feature of the mandible of the Tabūn woman is the upright position of its ascending ramus. Its gonial angle (left) is only 104°; in an Australian it is 115° (Table LXX, p. 229).

A survey of all the anatomical features of the mandible of Tabūn I leads us to the conclusion that most of them must be regarded as Neanderthaloid; this is also true of the characters of the teeth. The double opening for the mental branch of the inferior dental nerves and the genial pit and impression on the lingual aspect of the symphysis are as in the mandibles of the Neanderthal races of Europe. And yet we are of the opinion that the Tabūn woman had retained more primitive features in her mandible than did her Neanderthal cousins of Europe.

TABŪN II (Pls. XV, XVI, XXVI)

A profile drawing of the large solitary mandible from et-Tabūn is given in Fig. 145. From its massiveness there can be no hesitation in assigning it to a man. Indeed, there is only one human specimen which overshadows it in mass: that of the Heidelberg mandible which we reproduce for comparison in Fig. 146. In spite of the fact that Tabūn II is much more robust than that of the woman (Tabūn I) and shows other distinguishing features, notably an early stage of chin development, we are of the opinion that both male and female are probably of the same race, as well as being of the same time. The teeth of the two are essentially the same; X-ray examination of the bony parts of the mandible reveals the same trabecular pattern.

Measurements relating to this mandible will be found in Tables LXX–LXXII (pp. 229–30), the main measurements being given in Table LXX. Its length, taken in the manner described for the previous specimen, is almost the same as that of the Heidelberg mandible, namely 119 mm. The widths (Tabūn II, 130 mm.; Heidelberg, 131 mm.) are in near agreement. Nor are the differences great when we consider the height and thickness of the body of the mandible. The Tabūn jaw is the deeper at the symphysis and in the region of the canine and premolar teeth; in thickness (labio-lingual diameter) they are approximately alike. They differ greatly, however, in the cross-sections of the symphysis and in the region of the ascending ramus.

To consider the ascending ramus first; that of the Heidelberg mandible is the most massive that has been found amongst ancient humanity. The area of the ramus is 33·3 sq. cm., nearly twice as much as in the Australian, shown in Fig. 144 and listed in Table

LXX (p. 229). This Australian aborigine had an area of 18·2 sq. cm., the Bushman only 12·6 sq. cm., while the Tabūn male had 24·6 sq. cm. The ramus of the Heidelberg mandible seems to have expanded to the utmost limit; coronoid and condyle are directly continuous, having been caught in the upgrowth of the ramus and joined by the obliteration of the incisure. Yet in actual width the Tabūn male mandible is almost the same as that of La Chapelle man; as will be seen from Table LXXII (p. 230) the area in the Tabūn mandible is the greater. The ascending ramus of the Tabūn mandible is strongly developed; great strengthenings or bars transmit stresses from condyle and coronoid to the premasseteric thickening (Fig. 145).

The chief differences are to be noted in the region of the chin. In the Heidelberg jaw, as in that of Tabūn I, there is no chin; alveolar and basal elements of the symphysis continue in the same oblique plane, the alveolar being more massive than the basal element. The basal element of the symphysis of Tabūn II (Fig. 145) has become bent forward on the alveolar, an open angle being formed in front between the two. In addition, a bony eminence or prop is being built up in front to support the overhanging alveolar shelf. Thus is the chin evolved. In the Tabūn man the teeth and the alveolar element of the mandible seem to have retained their full development; they are not yet reduced. The floor of the mouth is being expanded by a forward movement of the basal element of the symphysis and new bone is being formed in front to provide a support for the incisor teeth.

The introduction of a chin or mental eminence requires an addition to our method of estimating the retreating angle which the chin region forms with the alveolar plane. The method is illustrated in Fig. 144 C; the line *a–b* from the infradental to the gnathion point indicates the angle of the symphysis. Both alveolar and basal elements lie in this axis in Tabūn I and in the Heidelberg mandible. In the former the symphysial angle is 61°; in Heidelberg it is the same. It is 72° in the Tabūn male; in the Australian a little more, 74° (Table LXXI, p. 229). But if we are to take notice of the chin, mental, or trigonal eminence we have to add a second axis, the axis *a–c* (Figs. 144, 145), which passes from the infradental point through the outermost or foremost tip of the chin, the pogonion. This latter axis forms an angle of 80° in Tabūn II and 86° in the Australian. The difference between the symphysial and the pogonial angles is a rough indication of chin development.

Those accustomed to measuring the degree of retreat or projection of the chin in relation to the lower or basal margin of the mandible may wish for a means of translating alveolar into basal angles. If the alveolar and basal borders were parallel, which they sometimes are, then the alveolar and basal angles should together equal 180°. Thus, if the alveolar angle is 61° as in the Tabūn woman, the basal angle should be 180 − 61 = 119°. It is 116°, because the basal border approaches somewhat to the alveolar as it passes backwards. The approximation is greater in Tabūn II, the basal angle being 5° less than expected, or 103°. The usual symphysial angle in the Krapina mandibles is 64°; in none of them does the chin eminence reach even the comparatively low development seen in the male Tabūn mandible.

Turning to the other important angular measurement of the mandible, that formed by the posterior border of the ramus and the lower margin of the corpus, we have to note that the angle in the male Tabūn mandible is 118° (right), whereas in the woman it is only 104°.

This angle measures 107° in the Heidelberg mandible, 110° in La Chapelle, and 115° in the Australian. The Tabūn male, in the openness of its angle, may be described as nearer the degree which prevails in modern races.

SKHŪL IV (Pl. XXVI c)

We now pass on to give brief descriptions of the mandibles from the Skhūl cave, beginning with the two most complete specimens, both adult males. A profile view of the mandible of Skhūl IV is shown in Fig. 147; the articular condyle and the coronoid process are missing on the left side, and the body and the ascending ramus on the right side from the canine backwards is badly crushed. The specimen is impressive rather for its dimensions than for its strength. There is a well-developed chin. We have here the beginning of all those characters with which we are familiar in the chin region of the Caucasian or of the Cromagnon stock. The section across the symphysis shows that the alveolar element has been reduced to a plate-like form such as is seen in the cross-section of the Bushman mandible (Fig. 144 A), although the Australian aborigine retains the older type (Fig. 144 C). The alveolar element carrying the incisor and canine teeth still projects somewhat in front of the chin; our drawing illustrates the manner in which the chin props up this part of the alveolar element and transmits its stresses to the basal bar. The basal element is advanced forward a stage more than in Tabūn II; the symphysis forms an angle of 75°, the chin prominence one of 89° (Table LXXI, p. 229). The chin region is deep, the height from upper to lower border being 42·5 mm., nearly the same as in Tabūn II. The main strength lies in its basal element, the labio-lingual diameter of this part being 15 mm., whereas the thickness of the alveolar part is only 7 mm.

The ascending ramus presents an extensive area, indicating, we infer, large muscles of mastication. The area of the ramus is 25·3 sq. cm., being thus larger than the ramus of Tabūn II (Table LXXII, p. 230). Yet in the development of strengthening bars, both in the ramus and in the body, it is less robust than the large Tabūn specimen. The width of the ramus is great, namely, 42·5 mm.; its height, however, was about 48 mm., 8 mm. less than in Tabūn II.

It is both wide and long as regards its major dimensions, being wider than Tabūn II and of almost equal length or height. One of the features in which it differs from the large Tabūn mandible is in its bigonial width, which is 110 mm. as against 88 mm. in the Tabūn specimen. Indeed, when we analyse all its characters, we see that this tall man, Skhūl IV, had a mandible which is essentially modern. It will be noted that the mental foramen is single, as in modern mandibles, whereas the mental nerves escaped by two openings in the Tabūn mandibles, which is the case in all the Neanderthal specimens. It seems to us highly probable that the mandible of Skhūl IV may represent a type which has evolved from the Tabūn type of lower jaw.

SKHŪL V (Pl. XVI)

The mandible of the tallest male of the Mount Carmel group is shown in profile in Fig. 148. It will be seen to have many resemblances to that of Skhūl IV but in most respects it is of a lighter build and formation. The mental foramen is single as in Skhūl IV. The chin is developed to a less degree; this is brought out by the symphysial and chin

angles (Table LXXI, p. 229) which show that the symphysis is less advanced and the alveolar element more protruding. The cross-section of the symphysis in Fig. 148 clearly shows that the alveolar element is less reduced than in Skhūl IV. The condition is much the same as that shown in the Australian symphysis (Fig. 144 C). The measurements of the symphysis and of the other parts of the body of the mandible are given in Table LXXI (p. 229).

The ramus is narrow and tall, springing from the body at a sharp angle which measures 107° (mean for right and left sides), the same angle as in the Heidelberg mandible, but the area and dimensions of the ramus are much less than in the Heidelberg specimen (Table LXXII, p. 230). The area measures 22·4 sq. cm., almost the same as in that of La Chapelle, but the shape is very different. The width in La Chapelle is 43 mm.; here it is only 36·2 mm. The former has a height of only 51 mm., while the Skhūl specimen is 60·5 mm. high (Table LXXII, p. 230).

CONDYLES OF MANDIBLE

There are certain other features relating both to this and to the other specimens which may be conveniently dealt with here. Skhūl V is the only specimen in which both condyles are preserved intact. They are represented as viewed on their anterior aspect in Fig. 149 B, C. The right condyle has been deformed by arthritis, as is the case in both condyles of Krapina J. The left condyle of the Skhūl specimen is normal. Its dimensions and degree of inclination to the coronal plane are given in Table LXXII (p. 230). There is nothing in these dimensions to distinguish the condyles of Skhūl V from those found in modern European mandibles. The contour of the articular surface is that met with in native Australian mandibles. There is no tubercle on the lateral aspect of the neck of the condyle, which is normally present in Neanderthal mandibles.

There is a condylar process, nearly intact, preserved on the right side of the large Tabūn mandible (Fig. 194 A). Unfortunately the lateral extremity has been broken away so that we cannot be certain that a lateral tubercle for ligamentous attachment was present, but the contour of the surrounding parts points to its presence. The Tabūn condyle is about the same width as that of Skhūl V, but it is much stouter in its antero-posterior diameter; the inclination backwards of its transverse axis is also greater (Table LXXII, p. 230). The two condyles of Skhūl VII are preserved, though broken from the ascending rami. The right one appears to be normal, measuring 21·2 mm. (medio-lateral) × 12·3 mm. (antero-posterior). It is relatively much thicker from front to back than any of the others, and the articular surface is more nearly plane than convex. The left condyle measures 22 × 15·6 mm. This exaggeration of the measurements is due to arthritic changes such as have taken place in the right condyle of Skhūl V, where the measurements are respectively 1·5 and 5·8 mm. greater than those of the undeformed side.

BASAL CONFORMATION

Another matter which can be best dealt with here relates to the conformation of the basal aspect of the Mount Carmel mandibles. In Fig. 150 the mandible has been set upright in the alveolar plane and viewed on its inferior aspect. Certain points in which the Tabūn and the Skhūl mandibles differ are brought out in this way. The basal part of

the mandible, as we have already pointed out (p. 217), forms a bony bar for transmitting forces to and from the front teeth. The basal aspect of the mandible of the Tabūn woman is shown in Fig. 150 A. The basal bar is wide, strong, and passes forward to end in the symphysial region, particularly in the basal part of the symphysis. The special basal bond in anthropoid mandibles is known in England by the term 'simian shelf'; abroad it has been given many names. The genio-glossus, the genio-hyoid, and the digastric take their origins from this element (Figs. 147, 148). In our drawings (Fig. 150) this basal symphysial junction is indicated by the letter '*e*'. The alveolar element carrying the teeth appears within the basal margin, which ends behind the post-molar prominence '*c*'. In Tabūn I the alveolar element disappears from view as it is traced forwards, but is completely exposed in front of and to the side of the symphysial region. The alveolar element in the mandible of an Australian (Fig. 150 D) scarcely appears in front of the symphysis and chin, but is visible within the ramus of the mandible from '*c*' to '*e*', practically in its whole extent.

The right half of the large male Tabūn mandible is shown in Fig. 150 B. The basal bar is thick and strong and ends in a massive expansion before it reaches the chin and symphysis. Beside B is set C, the left half of the mandible of Skhūl V. The marked reduction of the basal bar, as compared with that of the Tabūn specimen, is at once apparent. This reduction permits the alveolar element to be exposed both outside and inside the basal bar. A similar view of the left half of the mandible of Skhūl IV is shown in Fig. 150 E. The resemblance of its main outline to that of Skhūl V is at once apparent, but there is this difference between them: the basal bar in IV has retained its strength to a much greater degree than in V, but the opposite is the case as regards the alveolar element, which has undergone reduction in Skhūl IV. There appears to be a very great difference between the mandibles of Tabūn I and Skhūl V as represented in Fig. 150, but a closer inspection will show that they are the extremes of a single series, Tabūn II and Skhūl IV representing intermediate stages.

It is of interest to note that in the mandible of an Australian (Fig. 150 D) the basal bar is relatively strong, as in the Tabūn specimens, but is shorter and with a marked outward convexity, while the alveolar element is widely exposed inside the framework of the basal bar.

EXPOSURE OF THE ANGLE OF THE MANDIBLE IN A FRONTAL VIEW

The varying degree of exposure of the angle of the mandible is illustrated in Fig. 151. The drawings represent anterior views of the mandibles of Tabūn I (A), Tabūn II (B), and Skhūl V (C). It will be noted at once that in such a view the Tabūn female mandible presents an appearance which is markedly different from that of the Skhūl man. The difference depends on two factors: in the Tabūn mandible the angle is drawn inwards, while the prominence of the premasseteric eminence is much greater than in modern mandibles. The result of this, as seen in the Tabūn mandible, is that the outer or masseteric surface of the ascending ramus is visible to a slight extent, while in the Skhūl mandible the angle and the ascending ramus are a prominent feature in a front view of the face. The Skhūl arrangement is the one which prevails amongst living races of mankind, and in this feature both the Skhūl mandibles are modern. The mandible of Tabūn II serves to bridge the gap between the Tabūn and the Skhūl types (Fig. 151 A and C).

SKHŪL VI

Having discussed the more important features of the four most complete mandibles, we now turn to the enumeration and brief description of the less complete mandibles, all from the Skhūl cave. Skhūl VI, a male, was not as tall as either Skhūl IV or V, yet was over 1,700 mm. (5 ft. 7 in.). All that was recovered of his mandible is shown in Fig. 152. As reconstructed in our drawing the ramus of Skhūl VI has an area of 24·2 sq. cm., almost equal to that of the Tabūn male (No. II). Nevertheless it is much less strongly developed, being 2–3 mm. less in thickness at all points such as the neck of the condyle and at the premasseteric eminence. The diameters of the ramus are given in Table LXXII (p. 230) and that of the body of the mandible in Table LXXI (p. 229). The body of the mandible is not much less in height than in Skhūl IV and V.

SKHŪL II

We have a representative series of teeth of this woman, but all that was found of the mandible is represented in Fig. 153, A being a cross-section of the symphysis, B a profile view of the right side (reversed), and C an anterior view of the fragment. The two canine teeth have been set into their respective alveoli to indicate the relative height of the mandible. The alveolar border extends on the right to M–1 and on the left to the Pm–2. The mental foramen is single, as in the other Skhūl mandibles.

One has but to compare the cross-section of the mandibular symphysis of the Tabūn woman (Fig. 143) with the one belonging to the Skhūl woman (Fig. 153) to realize the range represented in our series. Tabūn I has no chin, only a deeply receding symphysis, whereas Skhūl II has a shallow symphysis and a prominent chin. The chin and symphysial angles are given in Table LXXI (p. 229) and are represented in Fig. 153 A. The symphysial angle is 78°, the chin angle 90°, both well within the modern range. The mandible of this woman was shallow and only moderately thick as may be seen from the data given in Table LXXI. Its depth at the symphysis was 29·5 mm., its thickness 12·4 mm. A fracture has destroyed the site of the genial fossa and genio-glossal impressions, but it is certain that the pit could not have been deep nor is it probable that there had been a genial spine. The basal bar is well demarcated, being separated from the alveolar element by a deep groove or sulcus (Fig. 153 B, C, *s*). The sulcus is deep where it flanks the rounded papular eminence of the chin.

It is a remarkable fact that female mandibles not unlike the type represented by Skhūl II are found in Saxon and earlier tombs of England, especially in Megalithic graves. It may prove to be a type that is linked to sex.

SKHŪL VII

The teeth of this remarkable woman have been described in Chapter XIII, p. 204. Their characters are Neanderthaloid and if they had been found by themselves would have been assigned without hesitation to an individual of the Palaeoanthropic genus. In Fig. 154 B we give a reconstruction of the mandible based mainly on the left half of the bone and drawn at approximately right angles to the mid-sagittal plane. The length of the molar tooth row is 31 mm.; they have wide but not long crowns. The roots of the two premolars are *in situ*, but the anterior margin of the alveolar part carrying the canine and

incisor teeth is damaged, as is the region of the chin. With these indications, however, we have attempted to complete the dental series and to give some idea of the probable form of the symphysial cross-section.

The length of the dental arch in our reconstruction is 52 mm., quite a Neanthropic amount and certainly not an over-estimate. The ascending ramus is seen to rise more or less vertically from the body of the mandible, as it did on the right side (Fig. 154). It is not a wide ramus, the minimum width measured on the bone being 32 mm., but 2–3 mm. must be added on account of crushing. It is, however, very thick and strong, with a rounded angle, a moderate masseteric development, and a pronounced thickening of the anterior (coronoid) part of the Y-shaped ramal strengthening bar.

The cross-section made at or near the symphysis (Fig. 154 A) and that made at the site of the second molar (Fig. 154 C) show that the body of the mandible was of medium height but very thick. It is impossible to determine the angle of the symphysis with precision; the section shown in Fig. 154 A probably errs in making the retreat of the symphysis too great. There appears to have been an eminence on the symphysis which represents the chin and was developed to about the same extent as that seen in Skhūl V (Fig. 148). The alveolar element of the symphysis is greatly developed, having an antero-posterior diameter of 14·8 mm., while in the basal bar this diameter is only 11 mm. The alveolar element overhangs the genial pit, there is no mental spine, only a rough triangular area for the origin of each genio-glossal muscle, while below are the longitudinal areas for the genio-hyoids separated by a low median ridge (Fig. 154 A). Fig. 154 C shows the relative thickness of the mandible at the site of the second molar and the pronounced mylo-hyoid ridge. Measurements of this and the symphysial diameters are given in Table LXXI (p. 229).

The mandible of this woman possesses primitive features which are usually associated with the Neanderthal type of humanity. As we have seen, the forearm bones and the femur show similar characters. The picture of the face suggested by the mandible is one of moderate length with an absence of prognathism.

SKHŪL I[1]

It is not easy to determine the age of this child; the bones of the skeleton seem in advance of the stage reached by the dentition, but as a provisional estimate we suggest four and a half years. All the milk teeth were in use, but the wear on the second milk molars is slight, the cusps being still intact. The crowns of the first permanent molars are formed and lie within the alveolar crypts.

X-ray skiagrams show that the crowns of the canines and incisors are formed while the crowns of Pm–1 and Pm–2 are partially formed.

A drawing of the reconstructed mandible is given in Fig. 155 A. Where parts are missing on one side they are present on the other. The dimensions are given in Table LXXI (p. 229) and descriptions of the teeth on pp. 302–7. Below the figure of the Skhūl mandible we have placed one of the jaw of the Gibraltar child, the permanent teeth of the latter being in a slightly more advanced stage of development. The difference in size is considerable and this may be due to the influence of sex, for Skhūl I is probably a girl and the Gibraltar child was almost certainly a boy. The symphysis of the Gibraltar infant is

[1] A full description of this child and of the mandible is given in Chapter XIX.

24 mm. deep, of Skhūl I only 20·5 mm., and whereas the antero-posterior diameter of the Gibraltar specimen is 13·5 mm., in Skhūl I it is only 10·8 mm. Yet there is no doubt as to the general resemblance of the Skhūl mandible to the Gibraltar one and the latter is certainly a child of the Neanderthal type. Nor can we overlook the fact that both mandibles differ in a corresponding direction from the modern specimen (Fig. 155 C). We note, however, two points which must be taken into account in settling the racial affinities of the Skhūl type. There is but one mental foramen in the Skhūl mandible, as in the modern mandible, while there are two in the Gibraltar specimen, as is usual in Neanderthal mandibles. Also the slope of the chin is greater in the Gibraltar mandible and the chin eminence is barely apparent.

A view from above of the Skhūl child's mandible is given in Fig. 156 B and Pl. XXII D. On one side is placed a similar drawing of the right half of the Gibraltar bone (C), and on the other is the left half of the mandible of the English child shown in Fig. 155 C. The outstanding feature of the Skhūl mandible is its width of arch, especially the width in the canine region. This is also a feature of the adult Skhūl mandible, as it is of the Neanderthal group of races. The Gibraltar child has a wide bi-canine diameter, but not to the extent represented in the Skhūl mandible. The bony framework is noticeably more robust in the Skhūl and the Gibraltar specimens than in the modern one represented in Fig. 156 A.

SKHŪL X

This child, probably a boy, we estimate to have been about one year older than the one just discussed. We have the symphysial part of the mandible and a fragment of the body bearing the left m–2 and part of the m–1. There are also some loose teeth, including the crowns of two upper molars, one more advanced in development than the other. These we regard as the M–1 of the left side; the less developed as the M–2 of the right side. It is possible the first was in course of eruption; the cusps are unworn. The crowns of the premolars, as of the incisors and canines, although still within the alveoli are almost completely formed. Of the lad's skeleton we have only the distal part of the right humerus, which might be that of a seven-year-old modern boy. We are of opinion that Skhūl X was somewhat older than the Gibraltar boy.

Three views of the symphysial fragment of Skhūl X are shown in Fig. 157. A is a cross-section of the symphysis, B is an anterior view, and C represents the lingual aspect of the symphysis. This mandible is considerably higher than is the case in Skhūl I (Table LXXI, p. 229). Its height is 29·5 mm., 9 mm. more than in Skhūl I and 5·4 mm. more than in the Gibraltar child. Its antero-posterior diameter is also great, being 10·8 mm. in Skhūl I, 13 mm. in Skhūl X, and 13·5 mm. in the Gibraltar infant. But in the latter the greater antero-posterior diameter lies in the alveolar portion of the symphysis, whereas in Skhūl X the alveolar and basal parts are equal in thickness.

Viewed from the front (Fig. 157 B) the triangular or heart-shaped chin eminence is definitely developed, and yet when seen in profile (Fig. 157 A) the elevation is actually slight. As in modern man the chin develops with the eruption of the permanent teeth and also with the full functioning of the sexual glands.

On the posterior aspect, semi-diagrammatically depicted in Fig. 157 C, there is a wide shallow fossa from the floor of which arise the two genio-glossal muscles, taking origin from flat rough areas separated by a slight median ridge; immediately below are the

elongated areas for the origin of the genio-hyoid. Above the genio-glossal origins is the usual median vascular opening (Fig. 157 A, C) which demarcates the alveolar area above from the basal area below. The digastric muscle arises from the lower aspect of the basal element.

Having now completed our account of the individual specimens and compared some of their features, we propose to discuss some general matters relating to the anatomical features of the group, dealing first with the characters seen on the lingual aspect of the symphysis. Fig. 158 shows a series of drawings representing the origin of the genio-glossal and the genio-hyoid muscles in the mandible of the Tabūn woman (A), in the Bushman (B), and in an Australian (C). In the mandible of Tabūn I we meet with the usual primitive condition—a wide genial fossa with rough areas separated by a low median ridge; below arise the genio-hyoid muscles from rough, narrow oblong areas separated by a raised line of bone. The digastrics arise from the under surface of the basal element of the mandible. In Fig. 158 B we represent the condition found in the Bushman. There is an extremely wide and open genial fossa to which Professor Arthur Thomson (1916) has called attention. The alveolar element has become attenuated in the Bushman to form a plate (Fig. 144 *a*), whereas in the Tabūn specimen this forms a thick pillow or pad. The manner in which the muscles arise in B (Fig. 158) is very similar to that seen in A.

Turning now to the condition seen in the mandible of an Australian, there is an alveolar pillow, not so developed as in A, yet fairly convex, and there is a small genial fossa. The fossa has become partly filled by a deposit of new bone at the origin of the genio-glossal muscles. Previously we have described a similar filling up of a fossa which occurs in the ulna at the insertion of the brachialis muscle. In Skhūl IV the genial fossa has been filled up to a greater extent than in the Australian. The final stage, seen in modern mandibles, is a complete filling up of the pit from the basal element and the production of bony spines in the origin of the genio-glossal muscles. Weidenreich (1936) has found true genial spines in some of the Sinanthropus mandibles. There is no trace of such bony spines in the Carmel mandibles, nor are we convinced that they have been found in any mandible attributed to Neanderthal man, although one of the Krapina mandibles (J) does show a bony projection from the region of the fossa.

EVOLUTION OF THE CHIN

The degree to which the chin is developed has been touched upon in the course of our description, but there are certain features, represented in Figs. 159 and 160, which deserve further attention. In Fig. 159 A is given an anterior view of the mandible of Tabūn I showing the manner in which the alveolar element sinks down into the basal element without any kind of break; there is no chin. The same aspect of the mandible of Tabūn II (Fig. 159 B) shows that a change has taken place; the basal element of the symphysial area has grown upwards and has invaded the territory of the alveolar element. The advance is marked by a depressed wave of bone which marks the junction of the basal with the alveolar bone. Tabūn II shows an early stage in the evolution of the chin.

The anterior aspect of the chin region of Skhūl V is shown in Fig. 160 A. The basal element of the chin (*b*, *b*) has extended its development, as compared with the stage reached in Tabūn II, and has invaded more widely the territory of the alveolar part of

the symphysis. The stage reached in chin development in Skhūl V is very similar to that found in the Australians (Fig. 160 B). It is interesting that both in the character of the chin and in the condition of the genial fossa Skhūl V should have reached a stage equal to that which prevails among the natives of Australia, while in Skhūl IV chin formation reaches an almost European standard.

CHANGES IN THE LINGUAL ASPECT OF THE MANDIBLE

Certain characters to be noted on the lingual aspect of a modern mandible of primitive type are depicted in Fig. 161. These are explained in detail in the legend to the illustration, but we may draw attention now to certain basal parts in Fig. 161, lettered *b*, *bb*, *d*, *mb*, and to the alveolar units *a*, *la*, *mr*, *mp*. Also the sulcus which separates the basal from the alveolar elements on the lingual aspect of the body of the mandible is deeper and wider than on the buccal aspect. The internal aspects of the four most complete Carmel mandibles are presented in Fig. 162. We are impressed by the points in which they and the modern mandible (Fig. 161) agree, rather than by those in which they differ. We have the same two elements, basal and alveolar, disposed on a similar plan in all. There is the same Y-shaped ramal thickening or support on the medial aspect of the coronoid process (Figs. 161, 162 *rb*). The only significant difference is in its degree of development, being stronger in the two Tabūn specimens than in the Skhūl examples.

It will be noted in the Tabūn mandibles that the mylo-hyoid ridge (Fig. 162 B, C, *mr*) which gives attachment to the muscular hammock forming the floor of the mouth is unbroken, as in the anthropoid apes. It is interrupted in the mandible of modern races (Fig. 161 *mr*). The break is due to a change in the disposition of the sub-lingual salivary gland. Although the internal surfaces of the mandibles of both Skhūl IV and V are not perfectly preserved, there can be little doubt that in them the modern form of mylo-hyoid ridge prevailed (162 A, D).

The alveolar bone forms an elevation or swelling on the lingual aspect of the corpus of the mandible in both the Tabūn jaws (Fig. 162 B, C, *a*). This is also apparent in Skhūl V, the development being to about the same extent as in the Australian mandible. On the other hand, the lateral alveolar bone is greatly reduced in Skhūl IV—a modern feature. It is also noteworthy that with the reduction of the alveolar element in Skhūl IV there has been an increase in the basal portion, whereas in Skhūl V it is the basal, not the alveolar element, which has suffered the greater degree of reduction.

MYLO-HYOID CANAL

The Tabūn teeth and mandibles resemble those from Krapina in many features, more so than is the case with the Skhūl people. In Fig. 163 we illustrate a point in which the Krapina and the Tabūn mandibles agree. The mylo-hyoid groove, instead of being open as is usual, is converted into a canal or tunnel in its upper part. Kramberger observed this in two of the Krapina mandibles. It occurs in the Tabūn man (Fig. 163 A) but not in the Tabūn woman (Fig. 162 C).

MANDIBULAR GROUND PLAN

There is still another aspect of the mandible which we must consider before bringing this survey to an end. It is the aspect represented in Fig. 164, where the mandibles are

arranged horizontally on the alveolar plane and drawn from above. They have been arranged so that the post-molar line (*Y–Y*) corresponds in all. The post-molar transverse line divides the mandibular lever into two parts, an anterior tooth-carrying portion, and a posterior part on which the muscles of mastication are inserted. These two segments are almost equal in length in the case of the Tabūn mandibles (Fig. 164 A, B), the muscular part of the lever forming about 50 per cent. of the whole. The muscular segment is short in Skhūl V, forming only 41·9 per cent. of the total length (Fig. 164 C). In the case of the most massive mandible found at Krapina (Fig. 164 D) the muscular part is 48·6 per cent. of the whole, the tooth-bearing part being slightly the longer. We have here additional evidence of the reduction in masticatory power in the Skhūl people.

These results may be compared with others, obtained in another way. In Table LXXII (p. 230) measurements are given of the muscular and dentiferous segments made along a line illustrated in Fig. 144 D. Here, however, is brought out the fact that in Skhūl IV the muscular segment is relatively longer than in the large mandible of Tabūn II.

We have a special reason for reproducing the drawings in Fig. 164. We wished to compare the mandible of the Tabūn man (Fig. 164 B) with that of the massive male Krapina J mandible. If the Tabūn specimen excels in length, the Krapina mandible predominates in the transverse diameter of its muscular segment. The muscles of mastication must have been exceedingly strong in this Krapina man, a contrast to the condition in Skhūl V. It will be seen from Fig. 164 how strong is the mandibular lever in Tabūn II where it is crossed by the post-molar line. Its transverse diameter here is 20 mm., in Skhūl V only 15·2 mm., while in the La Chapelle mandible it rises to 23 mm. and in the Heidelberg jaw it reaches the record measurement of 23·5 mm.

SKIAGRAMS OF THE MANDIBLE

A series of skiagrams of the Mount Carmel mandibles are reproduced in Pls. XXVI, XXVII. The most interesting of these for our present purpose, that of determining the relation of the Skhūl to the Tabūn people, are the lateral views of the molar region. Any lingering doubt as to the rightness of our opinion that the Tabūn man, represented solely by the mandible, is of the same race as the chinless Tabūn woman is dispelled when we note that in both there is the same short-rooted first molar (Pl. XVI A, D). The first molar roots are of normal length in both Skhūl IV and V (Pl. XXVI C, E).

When we turn to the incisor and symphysial region of the Tabūn woman (Pl. XXVI B) we note the long-rooted incisors and the small proportion that the basal element forms as compared with the alveolar. It is well to note, too, that a short median process of dense bone, foreshadowing the chin, rises upwards from the basal bar. In Tabūn II, in spite of a defect in the specimen, the wide interval between the roots of the incisors and the partially developed chin and basal bar is to be noted. The extent of this interval and the nature of the bond which unites the alveolar element to the base may be well seen in any modern mandible. The symphysial region of Skhūl V shows an advance towards the modern construction on that seen in the mandible of Tabūn II. The roots of the incisors have shortened and the dense bone from the basal bar, forming the basis of the chin, has become increased.

We may here draw attention to a difference in quality of the bone in the Skhūl mandibles as compared with that in the Tabūn specimens. The trabeculae of the Tabūn jaws have

sharp outlines; those of the Skhūl specimens are blurred and ill-defined. This we believe to be due to a difference in their preservation. The texture of the surface of most of the Skhūl bones is 'earthy', and appreciably less dense than the Tabūn specimens. This is evidently also the case with the inner structure. The lack of sharp definition of the inner structure of the Skhūl specimens becomes more apparent in the series shown in Pl. XXVI. There we reproduce skiagrams of the right side of Tabūn II, the left of Skhūl IV, the left of Skhūl V, and the right side of Tabūn I.

The trabeculae of the ramus of a modern mandible fall into two series. There is a pressure series beginning at the back of the condylar neck, descending into the ramus and uniting in front to form the basal bar already described (pp. 220–1). There is a traction series which transmits the pull of the temporal muscles, beginning in the coronoid process and descending in the Y-shaped bar (Figs. 161, 162) to be finally distributed in the alveolar element of the body of the mandible, especially in the molar and premolar region. The canal for the dental nerve lies between the traction and the pressure series.

When we turn to the mandible of the Tabūn man (Pl. XXVI A) we find the same two series, only the trabeculae are three times as numerous, with smaller lattices and stronger trabeculae leaving the front of the condyle to join the traction series. In spite of the obscurities in Skhūl IV we recognize a system which is in some degree intermediate between that seen in a modern mandible and in Tabūn II. The same two systems of trabeculae are apparent in the mandible of Tabūn I, but the arrangement shows certain peculiarities. The pressure (basal) system of the ramus forms a close leash of trabeculae which proceed forward to end in the basal bar as far as the roots of the third molar. The traction series, especially the relay from the condylar process, is particularly strong.

In a lateral view of the mandible of the infant, Skhūl I, the two systems of trabeculae can be seen but the series arising from the front of the condylar process is still joined to the basal system, being intermediate in position between the coronoid process above and the angle below (Pl. XVI F).

SUMMARY

We have given a description and illustrations of the various mandibles enumerated at the beginning of this chapter and it now remains to sum up the conclusions which we think the evidence permits us to draw. We have two types represented in these mandibles, a Tabūn type and a Skhūl type. Of the mandibles of fossil man which are known to us, the Tabūn type stands nearest to that found in the Neanderthal (Palaeoanthropic) group of Europe. Yet it differs in detail from the various forms found in Europe. The Skhūl type, as represented by Numbers IV and V, stands, on the other hand, nearer to the Neanthropic form of mandible among the Cromagnon people, especially the man from the Grottes des Enfants, selected by Verneau as typical of the Cromagnon group.

Yet if we leave our readers with the impression that the Tabūn and the Skhūl types are separate and distinct we should convey a wrong impression. In both Skhūl IV and V there are many points in which they resemble Tabūn II, just as this in turn is linked on to Tabūn I. We have, as in the teeth and the limb bones, members of the Skhūl group manifesting features which are regarded as characteristic of Neanderthal man. We have, for example, Skhūl VII, a woman who, in her mandible, as in her teeth and forearm bones, is Neanderthaloid in characterization.

Table LXX. THE MANDIBLE

	Tabūn		*Skhūl*		*Heidel-berg*	*La Chapelle*	*Krapina J*	*Aus-tralian*	*Bush-man*	*English (male)*
	I	*II*	*IV*	*V*						
Widths:										
Bi-condylar M 65 .	(133·0)	(130·0)	(132·0)	(132·0)	131·0	147·0	155·0	125·0	103·0	120·0
Bigonial M 66 .	93·0	88·0	(110·0)	98·0	110·0	..	..	100·0	90·0	95·0
Bi-coronoid M 65 .	(101·0)	98·0	(106·0)	112·0	..	..	..	103·0	91·0	96·0
Lengths:										
Maximum M 68 .	(95·0)	(119·0)	(118·0)	109·0	120·0	112·0	114·0	105·0	109·0	108·0
Gonial M 68 .	86·0	89·0	(94·0)	89·0	..	..	86·0	81·0	89·0	72·0
Ratios:										
Max. length–bi-condylar width .	71·3	91·5	89·3	82·5	91·6	75·8	73·5	84·3	106·4	90·0
Gonial length–bi-condylar width .	64·6	68·4	71·2	67·4	..	..	..	65·7	86·8	60·0
Bi-ment. width M67	48·0	55·0	(60·0)	45·0	..	..	..	48·0	41·0	45·0
Gonial angle M 79	104°	118°	111°	107°	107°	110°	118°	115°	119°	122°

Table LXXI. THE MANDIBLE

	Tabūn		*Skhūl*											*Krapina*			
	I	*II*	*I (child)*	*X (child)*	*II (fem.)*	*IV*	*V*	*VI*	*VII*	*Aus-tralian*	*Bush-man*	*Heidel-berg*	*La Chapelle*	*H*	*J*	*Nau-lette*	*Malar-naud*
Angle of chin*	72°	80°	90°	..	(90°)	89°	81°	..	..	86°	97°	75°	77°	74°	75°	..	..
Angle of symphysis* .	61°	72°	(80°)	..	(78°)	75°	69°	..	..	74°	84°	61°	63°	64°	64°	65°	70·5°
Height of symphysis M 69 .	30·3	(42·0)	(20·5)	29·5	(29·5)	42·5	36·5	..	(32·0)	31·2	32·3	37·5	36·0	40·0	42·3	33·0	27·5
Diameters of symphysis:																	
labio-lingual of alveolar element† .	13·2	17·0	10·8	13·0	(10·5)	8·4	11·0	..	(14·8)	12·0	6·0	16·0	14·0	..	..	13·0	11·0
labio-lingual of basal element‡ .	12·4	(13·0)	..	13·0	12·4	(15·0)	15·5	..	(11·0)	15·0	11·8	14·0	16·5	15·5	15·0	14·0	12·5
Mental foramen:																	
height of corpus .	27·5	42·5	(17·5)	..	28·6	40·5	36·0	..	..	30·5	30·0	34·0	..	35·0	..	..	..
labio-lingual diameter of corpus M 69(3) .	15·0	16·4	(11·8)	..	11·6	15·0	13·2	..	..	14·0	10·2	18·0	..	15·0	..	..	..
Second Molar:																	
height of corpus M 69(2) .	26·2	38·5	..	..	..	35·5	34·5	(25·7)	(30·0)	25·6	21·8	..	..	32·5	32·0	23·0	22·0
labio-lingual diameter of corpus .	15·2	18·0	..	..	..	(19·0)	13·0	(17·5)	15·4	15·5	17·0	..	..	16·4	..	16·0	15·0

* For the method of measuring these angles see Figs. 144, 145.
† Maximum labio-lingual diameter of the alveolar element of the symphysis above the genial fossa.
‡ Maximum labio-lingual diameter of the basal element of the symphysis below the genial fossa.

Table LXXII. THE MANDIBLE

	Tabūn		*Skhūl*				*Australian*	*Bushman*	*Heidelberg*	*La Chapelle*	*Krapina J*	*Malarnaud*
	I	*II*	*IV*	*V*	*VI*	*VII*						
Ascending ramus:												
area in sq. cm.*	18·9	24·6	25·5	22·4	(24·2)	..	18·2	12·6	33·3	22·8	..	..
minimum width M 71 *a*	38·0	40·0	(42·5)	36·2	(42·0)	(32·0)	37·5	35·0	52·0	43·0	..	35·0
minimum height†	49·5	56·0	(48·0)	60·5	(56·0)	(54·0)	50·0	37·8	62·0	51·0	..	46·0
Coronoid height‡	(57·6)	70·0	(65·0)	74·0	(65·0)	(65·0)	60·0	48·0	71·0	58·0	75·0	50·0
Condylar height‡	65·5	79·0	(67·0)	78·5	(71·0)	(73·0)	66·0	56·0	77·0	66·0	79·0	61·0
Condyle:												
width	(18·0)	(25·0)	..	23·0	..	21·2	22·7	15·5	..	29·0	..	..
antero-post. diam.	10·0	11·0	..	9·2	..	13·4	9·7	8·5	..	13·5	..	..
angle§	(24°)	20°	..	11°	..	..	13·5°	28·0°	..	..	(21°)	..
Condylo-incisor length‖	(102·0)	122·0	112·0	112·0	..	..	106·0	100·0	120·0	115·0	121·0	99·0
Ramal segment of condylo-incisor length‖	(48·0)	56·0	57·0	48·0	..	..	49·0	49·0	63·0	51·5	58·0	42·0
Ratio or ramal segment to condylo-incisor length	47·0	45·9	50·0	42·8	..	..	46·2	49·0	52·5	44·8	47·9	44·6

* The area is computed by placing a sheet of glass divided into 0·25 cm. upon ramal portion of a drawing of the mandible made in profile. The coronoid and condylar processes are excluded. The measurement extends to the lower margin and includes the entire area of masseteric insertion.

† Measured with sliding callipers from the deepest point of the sigmoid notch to the lower margin of the mandible, parallel to the posterior margin of the ascending ramus. The lower marginal point may be called the masseteric marginal (*mm.*) point and marked in pencil upon the bone.

‡ The coronoid and condylar heights are measured with callipers from the most superior points of the respective processes to the *mm.* point.

§ Angle formed by the long axis of the condyle with the transverse (coronal plane).

‖ Projected length from the posterior margin of the condyle to the anterior-superior margin of the medial incisor (Fig. 144 D). The ramal segment equals *E–F* in Fig. 144 D.

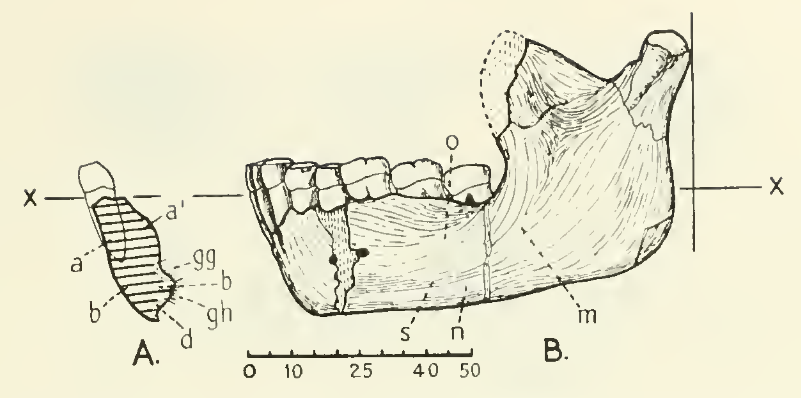


FIG. 143. THE MANDIBLE OF TABŪN I. A, cross-section of the symphysis; B, left lateral aspect, in profile. *X–X*, alveolar plane; *a*, *a'*, alveolar element of the symphysis; *b*, basal element of the symphysis; *gg*, origin of genio-glossus; *gh*, origin of genio-hyoid; *d*, origin of digastric; *m*, lateral prominence; *n*, marginal bar; *o*, alveolar bar; *s*, supra-marginal sulcus.

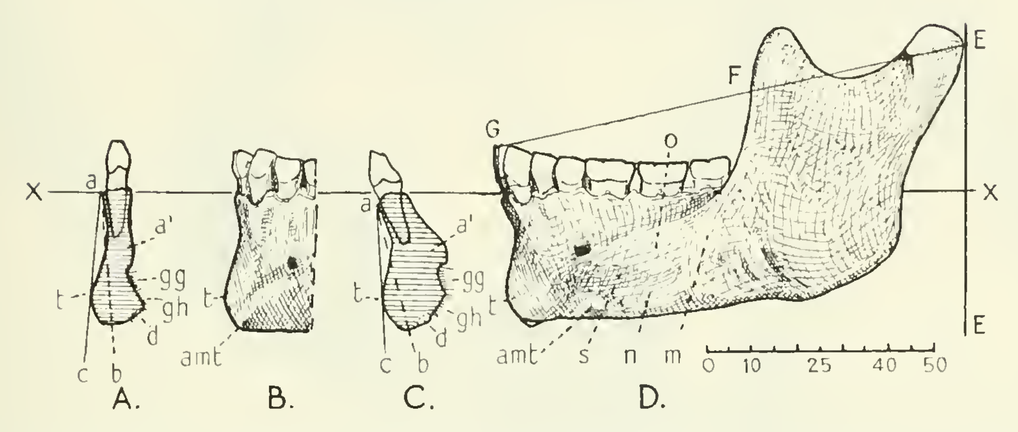


FIG. 144. A, cross-section of the symphysis of a Bushman; B, lateral aspect (profile) of the symphysial region of a Bushman; C, cross-section of the symphysis of a male Australian; D, left lateral aspect (profile) of an Australian mandible. *X–X*, alveolar plane; *E–F–G*, condylo-incisor line; *E–E*, vertical condylar plane; *a–b*, *a–c*, lines used in measuring the symphysial and chin angles (p. 218). *a'*, alveolar element of symphysis; *amt*, anterior marginal tubercle; *gg*, origin of genio-glossus; *gh*, origin of genio-hyoid; *d*, origin of digastric; *m*, lateral prominence; *n*, marginal bar; *o*, alveolar bar; *s*, supra-marginal sulcus; *t*, trigone of the chin.

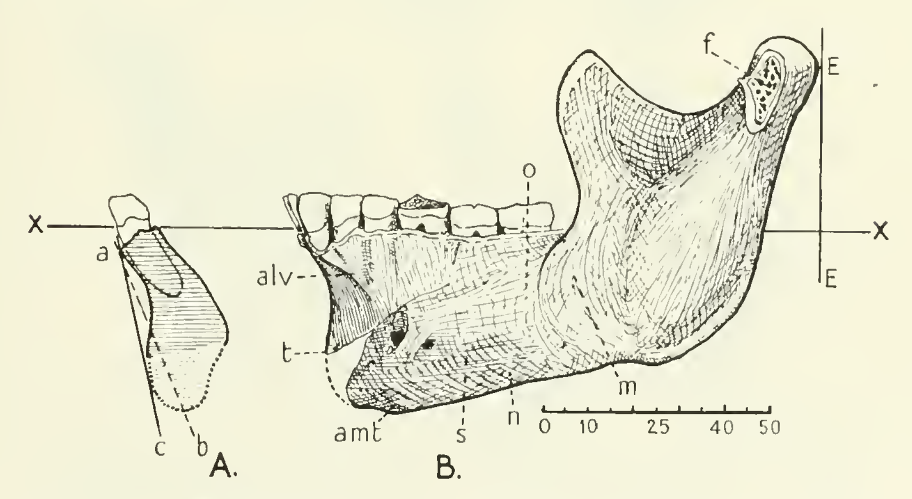


FIG. 145. THE MANDIBLE OF TABŪN II. A, cross-section of the symphysis; B, left lateral aspect (profile). The basal part of the symphysis is broken and is represented by stippling. *alv*, projecting alveolar element; *f*, fractured area of the condyle. Other letters as in Figs. 143, 144.

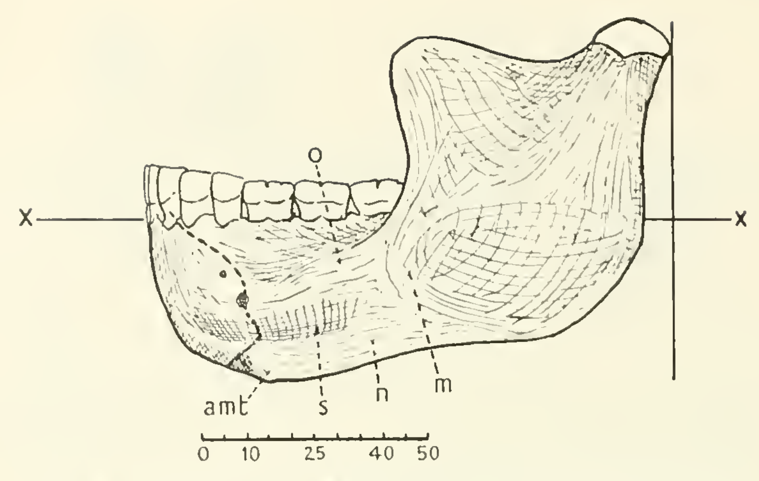


Fig. 146. The Heidelberg Mandible, Left Lateral Aspect (Profile). The lingual outline of the symphysis is indicated by a broken line. Letters as in Figs. 143–5.

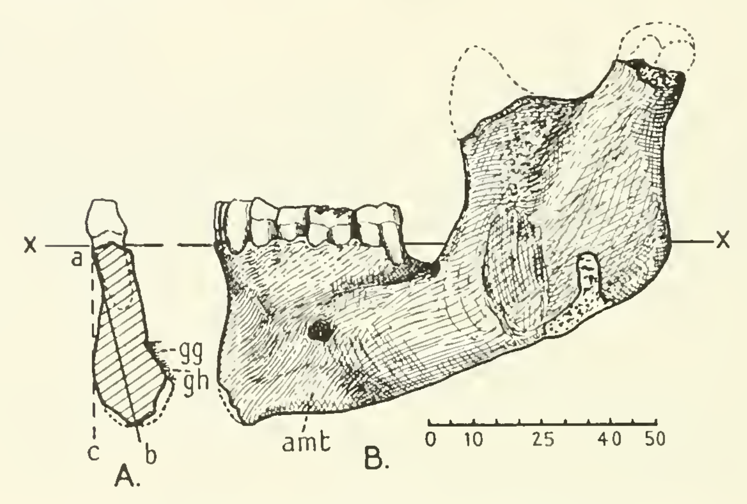


Fig. 147. The Mandible of Skhūl IV. A, cross-section of the symphysis; B, left lateral aspect (profile). Letters as in Figs. 143–5.

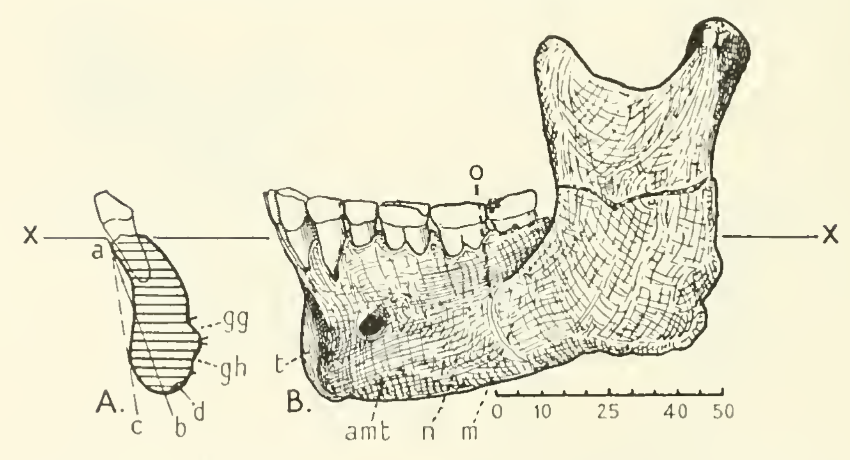


Fig. 148. The Mandible of Skhūl V. A, cross-section of the symphysis; B, left lateral aspect (profile). Letters as in Figs. 143–4.

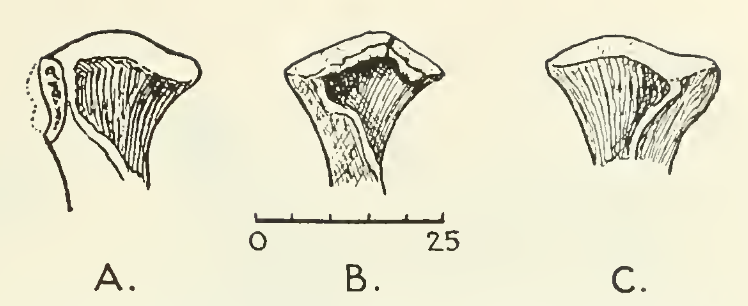


FIG. 149. ANTERIOR ASPECT OF THE ARTICULAR CONDYLE OF THE MANDIBLE. A, Tabūn II, right; B, Skhūl V, right (deformed by arthritis); C, Skhūl V, left.

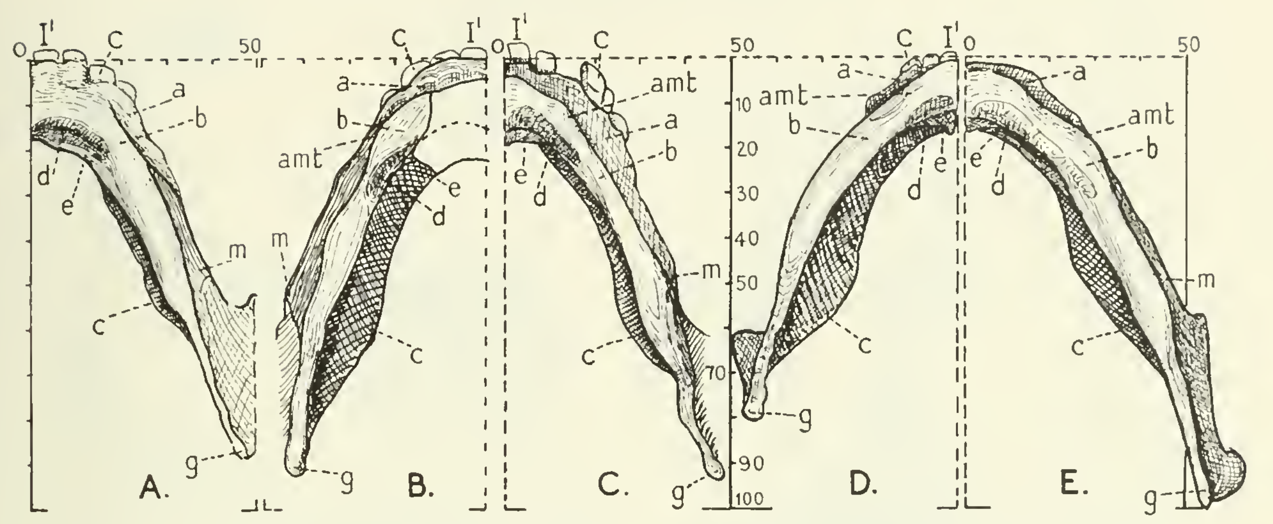


FIG. 150. INFERIOR ASPECT OF THE MANDIBLE, AS VIEWED AT RIGHT ANGLES TO THE ALVEOLAR PLANE. Only half of each bone is represented. A, Tabūn I, left half; B, Tabūn II, right half; C, Skhūl V, left half; D, Australian (male), right half; E, Skhūl IV, left half. *a*, exposed alveolar element; *b*, basal bar; *c*, post-molar alveolar prominence, at hinder end of the alveolar process; *d*, origin for digastric muscle; *e*, basal symphysial junction; *m*, lateral prominence; *amt*, anterior marginal tubercle.

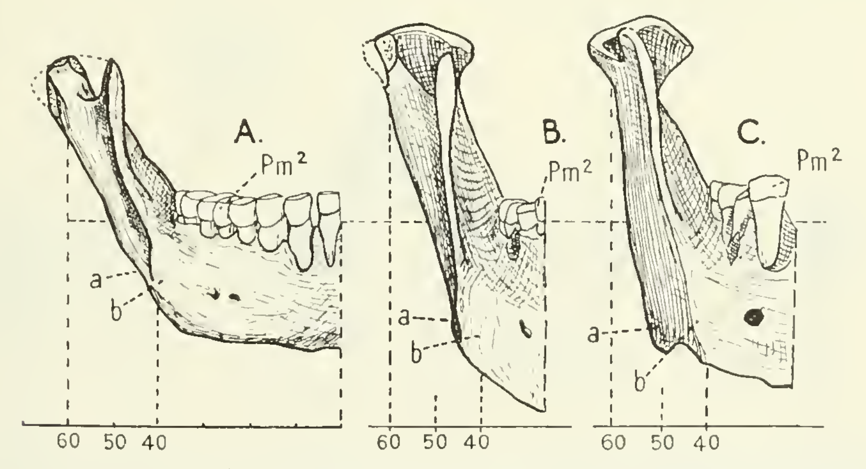


FIG. 151. A, Tabūn I, anterior aspect of the right half of the mandible, set in the alveolar plane. B, Tabūn II, part of the right half of the mandible represented as in A; C, Skhūl V, part of the right half of the mandible, represented as in A. *a*, angle; *b*, pre-masseteric eminence.

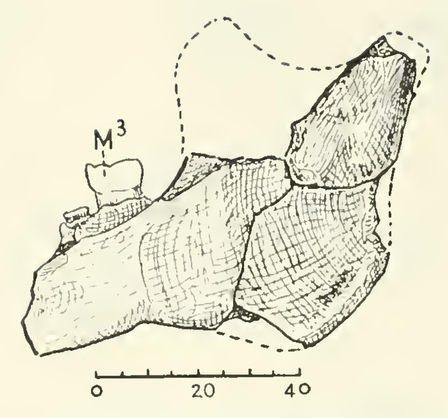


FIG. 152. SKHŪL VI. The left ramus and part of the body of the mandible (male). The broken line represents the missing parts.

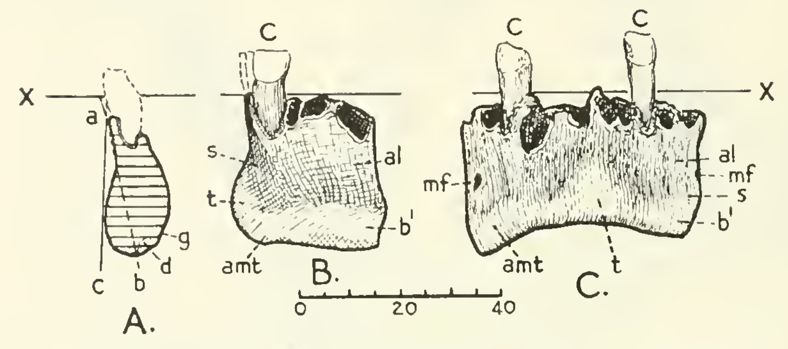


FIG. 153. FRAGMENTARY MANDIBLE OF SKHŪL II (FEMALE). A, cross-section of the symphysis; B, left lateral aspect, in profile; C, anterior aspect. *X–X*, alveolar plane; *a–b*, *a–c*, lines used in measuring the symphysial and chin angles; *al*, alveolar element of symphysis; *b′*, basal element; *amt*, anterior marginal tubercle; *g*, site of genial tubercle; *d*, origin of digastric; *mf*, mental foramen; *s*, sulcus between alveolar and basal elements of symphysis; *t*, trigone of chin.

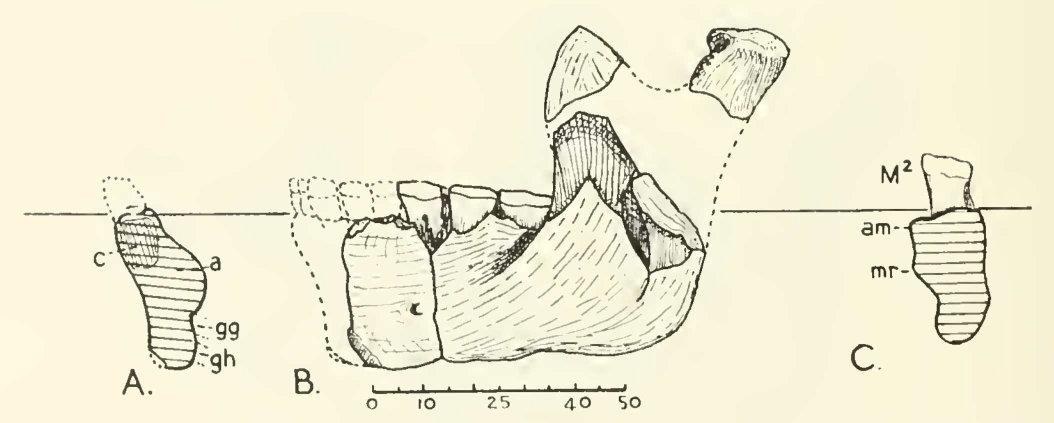


FIG. 154. MANDIBLE OF SKHŪL VII. A, cross-section of the symphysis; B, left lateral aspect (profile; reconstructed); C, cross-section at the site of the second molar. *a*, alveolar eminence on the lingual aspect of the symphysis; *c*, root of lateral incisor; *gg*, origin of genio-glossus; *gh*, origin of genio-hyoid; *am*, inner alveolar margin; *mr*, mylo-hyoid ridge.

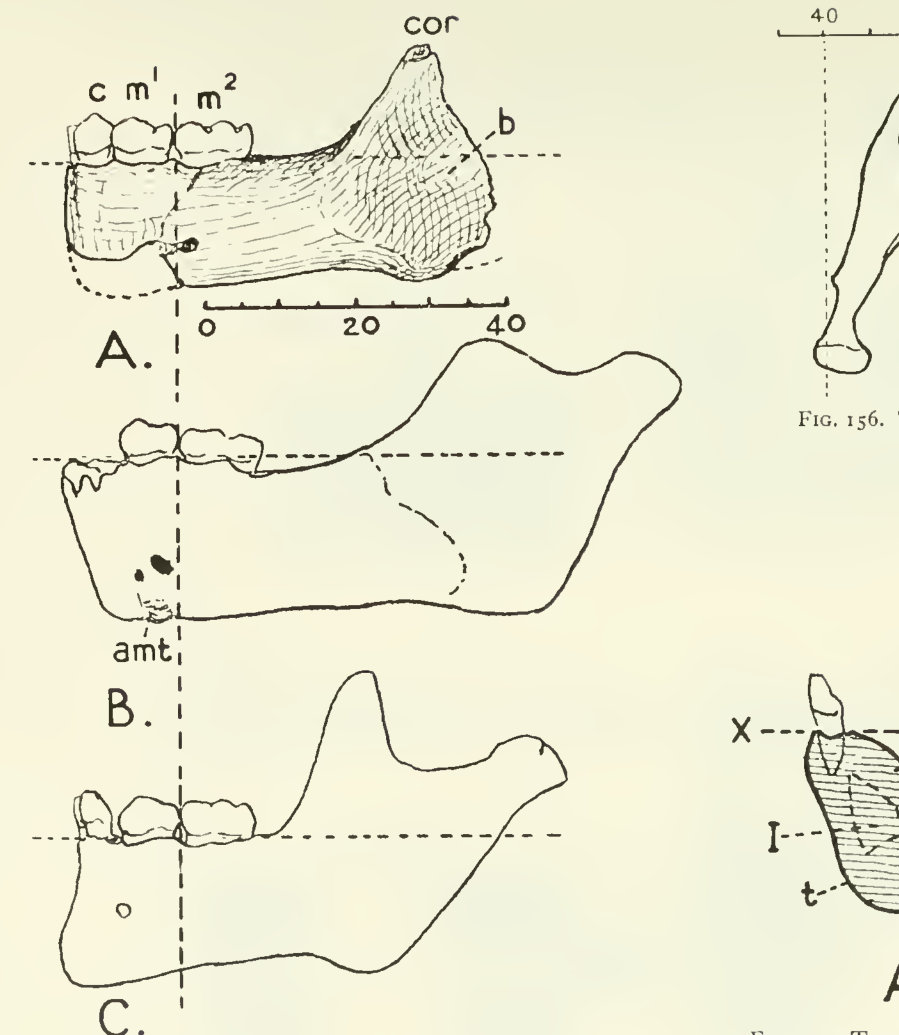


Fig. 155. Left Lateral Aspect (profile) of the mandible of A, Skhūl I (infant); B, Gibraltar (infant; outline made from a cast); C, English (medieval), of about the same age as Skhūl I. *cor*, coronoid process (broken); *b*, condylar thickening of the ramus; *ant*, anterior marginal tubercle.

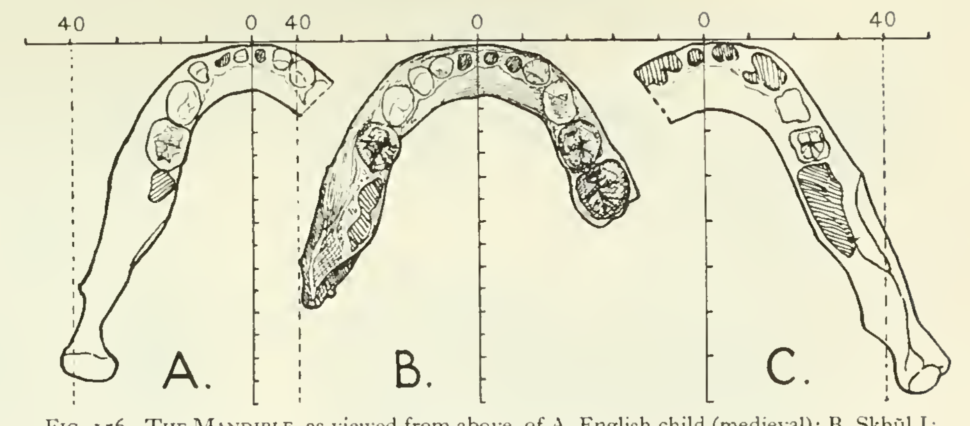


Fig. 156. The Mandible, as viewed from above, of A, English child (medieval); B, Skhūl I; C, the Gibraltar child.

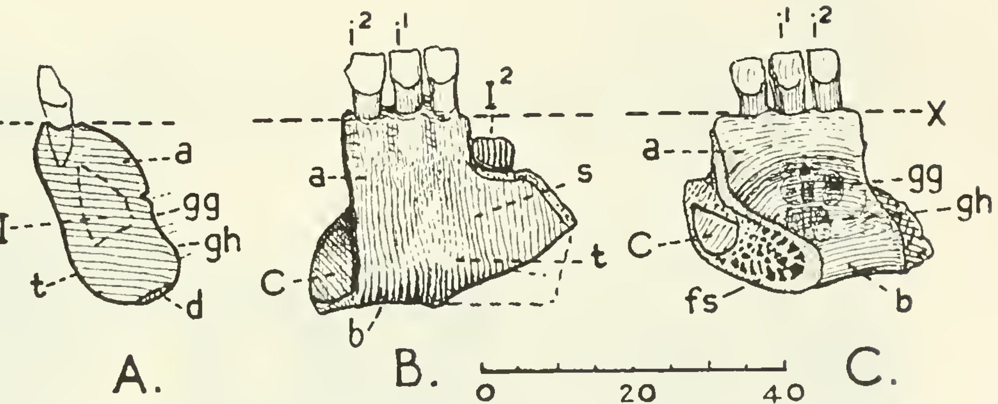


Fig. 157. The Fragmentary Mandible of Skhūl X (infant). A, cross-section of the symphysis; B, anterior aspect of the fragment, showing the chin; C, posterior aspect, showing the wide genial fossa. *X–X*, alveolar plane; *a*, alveolar element of symphysis; *b*, basal element of symphysis; *c*, crown of permanent Canine; *d*, origin of digastric; *gg*, origin of genio-glossus; *gh*, origin of genio-hyoid; *s*, sulcus between the basal and the alveolar elements; *t*, trigone of chin; *fs*, fractured surface exposing an oblique section of the basal bar.

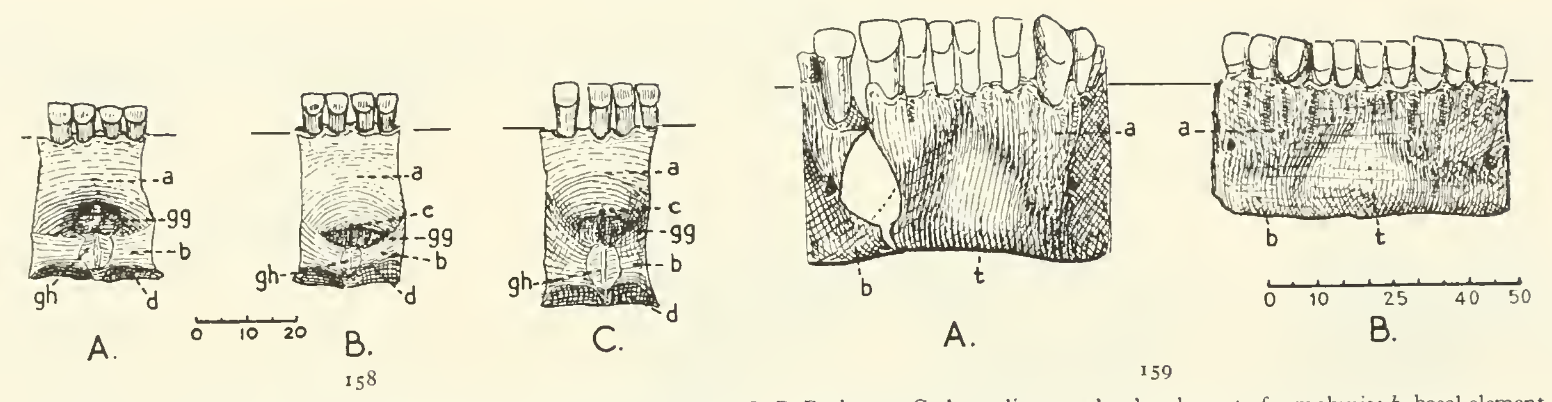


Fig. 158. Lingual Aspect of the Mandibular Symphysis. A, Tabūn I; B, Bushman; C, Australian. *a*, alveolar element of symphysis; *b*, basal element of symphysis; *c*, vascular canal separating the alveolar from the basal part (it is obliterated in Tabūn I); *d*, origin of the digastric; *gg*, origin of the genio-glossus; *gh*, origin of the genio-hyoid.

Fig. 159. Anterior Aspect of the Mandible. A, Tabūn II; B. Tabūn I. *a*, alveolar element of the symphysis; *b*., basal element of the symphysis; *t*, trigone of the chin.

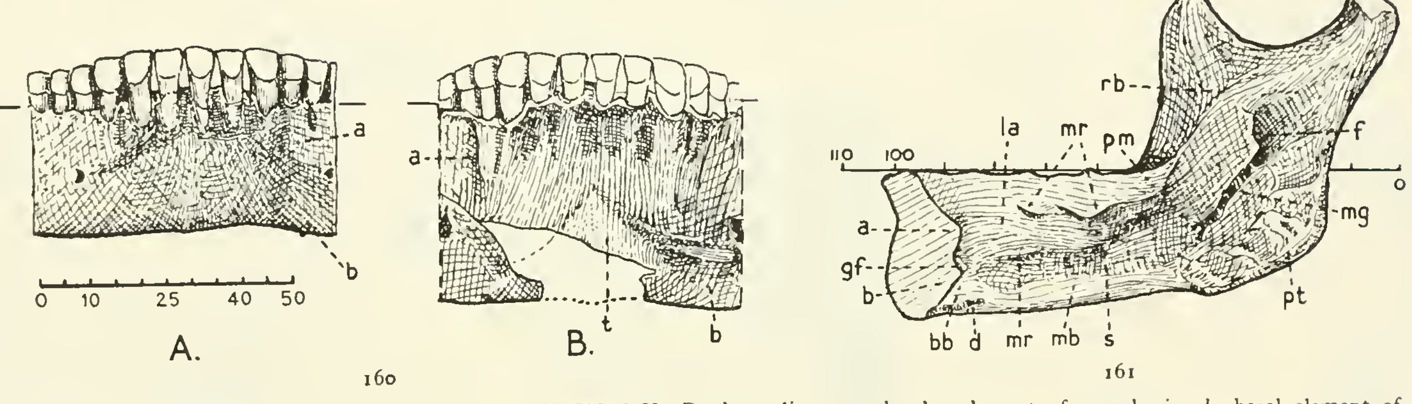


Fig. 160. Anterior Aspect of the Mandible. A, Skhūl V; B, Australian. *a*, alveolar element of symphysis; *b*, basal element of symphysis; *t*, trigone of chin.

Fig. 161. Lingual Aspect of the Mandible of a Male Australian. *a*, alveolar 'pad' or elevation of the symphysis (in section); *b*, basal element of the symphysis (in section); *bb*, basal bar (transverse); *d*, origin of digastric; *gf*, genial fossa (forming part of the sulcus system which separates the basal from the alveolar elements of the symphysis); *f*, mandibular dental foramen; *la*, lateral alveolar part; *mb*, marginal bar; *mg*, mylo-hyoid groove; *mr*, mylo-hyoid ridge (divided); *pt*, insertion of internal pterygoid muscle; *s*, internal supra-marginal sulcus; *pm*, post-molar prominence; *rb*, Y-shaped ramal bar.

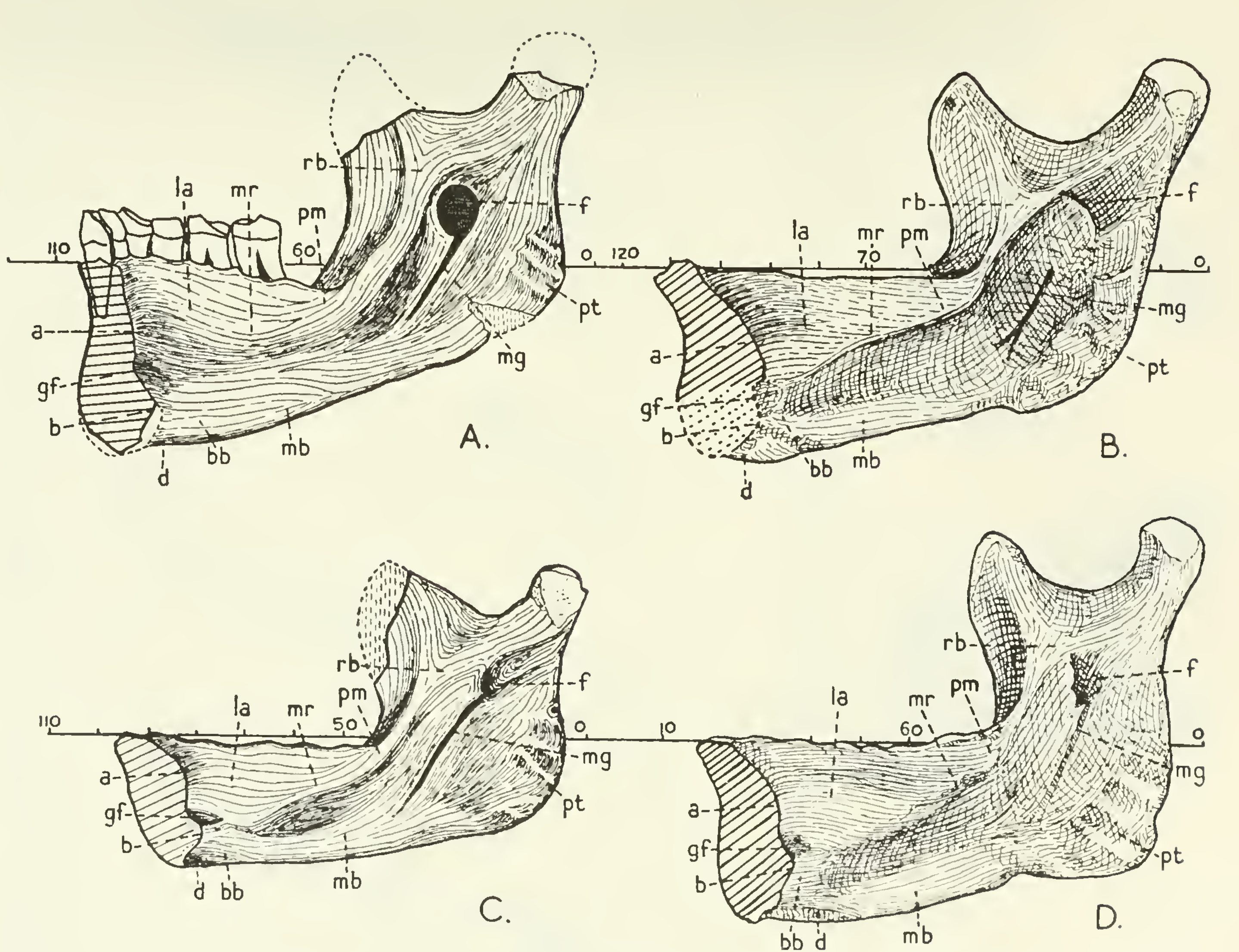


FIG. 162. THE LINGUAL ASPECT OF THE MANDIBLE. A, Skhūl IV (left, reversed); B, Tabūn II; C, Tabūn I; D, Skhūl V. Letters as in Fig. 161.

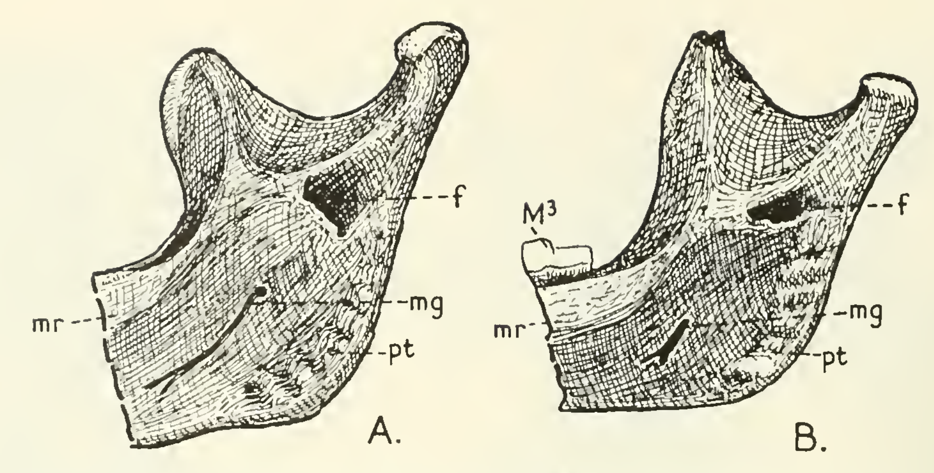


Fig. 163. Internal Aspect of the Ascending Ramus. A, Tabūn II; B, Krapina (after Kramberger, 1906, Plate V, Fig. 4). *f*, mandibular foramen; *mg*, opening of mylo-hyoid canal; *mr*, mylo-hyoid ridge; *pt.*, insertion for internal pterygoid muscle.

Fig. 164. The mandible as viewed from above, at right angles to the alveolar plane. A, Tabūn I; B, Tabūn II; C, Skhūl V; D, Krapina J (after Kramberger). *Y–Y*, post-molar transverse axis; *c*, tip of coronoid process.

CHAPTER XV

CRANIAL AND FACIAL CHARACTERS OF SKHŪL V

(Plates XVII, XVIII; Figs. 165–80)

WE begin our account of the skulls of the Mount Carmel people by giving a description of the cranial and facial features of the tallest of the men, Skhūl V. We have chosen the skull of this individual to serve as our type specimen for two reasons: because it is the most complete and the least distorted of our series, and because we know in great detail the skeletal structure of this man. In his limb bones and also in those of his trunk he differs significantly from the Neanderthal type of Europe and foreshadows the conformations we are familiar with in the limb bones of the Cromagnons of south France.

Having given a description of the cranial and facial features of Skhūl V, to serve as a basis of comparison, we shall pass in review the skulls of the other individuals, of the Tabūn woman (Tabūn I), of the tall man, Skhūl IV, of Skhūl IX (also a male), and of Skhūl VI (male) and VII (female). Thereafter we shall consider anatomical features of the group—the characters of their foreheads, orbits, nose, palate, mastoid region, masticatory system, and the conformation of the cranial cavity—analysing the anatomy of these and instituting comparisons with similar characters found in ancient and modern races. As a representative of the European Neanderthal people we shall depend very largely on the Gibraltar skull which one of us (T. D. McC.) has succeeded in freeing from the stalagmitic incrustations which have hitherto masked certain of its features, as well as carrying out certain repairs to the temporal and occipital bones. As the principal representative of the more primitive modern races, we shall employ the skull of a male Australian, one of robust conformation.

Skhūl V (Pl. XVII; Figs. 165, 166, 167, 168) was a man of about thirty-five years of age. This we infer from the wear of his teeth and from the condition of the sutures. The first molars are worn so that the dentine is exposed over half the area of the crowns, the area affected in the upper molars being the lingual half. Not more than 2 or 3 mm. has been worn from the flattened edges of the incisors. The sutures of the skull are open or are traceable throughout, save in the region of the pterion and in the part of the coronal suture covered by the temporal muscle. The sagittal suture appears to be obliterated in only a small section behind the obelion (Fig. 166). The lambdoid suture is quite open.

The chief features of the skull of No. V are apparent in the profile drawing (Fig. 165). The skull is set in the Frankfort plane which has been given a length of 200 mm. A vertical line bisects the auditory meatus and indicates the mid-auricular (coronal) plane. Two other vertical lines have been erected, the anterior vertical 100 mm. in front of the mid-auricular plane, and the posterior vertical 100 mm. behind this plane. Between the anterior and posterior verticals is drawn a horizontal line, 120 mm. above the Frankfort plane. We shall use this framework of lines throughout our description; it serves to give the expert an immediate understanding of the kind of skull with which we have to deal.

This skull has a maximum length of 192 mm., a long skull when we take modern skulls as a standard, but short in comparison with many Neanderthal specimens. The

pre-auricular length is 100 mm., the post-auricular 92 mm. (Fig. 165). Its greatest width is 143 mm.; the width represents 74·5 per cent. of the length, falling within the upper range of dolicocephally. The greatest width falls well forwards (cf. the vertical view, Fig. 165), rather more than two-fifths of the total length falling behind the widest diameter. Skhūl V agrees in this with modern man and differs from the Neanderthal type in which the greatest width, as in anthropoid skulls, lies still farther back.

The height of the vault is the chief feature in which this skull departs from the Neanderthal type of Europe. The vault at its highest point rises 121 mm. above the Frankfort plane (on the left side the meatus is 5 mm. higher than the undistorted right side and the height is therefore 5 mm. less). The mean height for modern European males may be given as 115 mm. In the La Chapelle skull the auricular height is 114 mm., in La Quina and Spy I, 111 mm., Spy II, 113·5 mm., in Krapina D, 113 mm., in the adult Gibraltar, 103 mm., and in the Rhodesian skull, 106 mm. Skhūl V resembles, on the other hand, the earliest of the European Caucasoids; in the large Predmost male (No. 3) the vault height is 122 mm., in the Old Man of Cromagnon, 125 mm. The tall man of the Grottes des Enfants, however, had an auricular height of only 115 mm. The brain tended in the Skhūl type, as in the modern skull, to expand upwards, lifting the vault, whereas in the Neanderthal type of Europe expansion was more in a horizontal than in a vertical plane.

Schwalbe measured the height of the vault in another way. He used a line drawn from the glabella to the inion as a base, the *g-i* base plane. If we use Schwalbe's base line then the vault of Skhūl V has a height of 100 mm., 10 or even 20 mm. more than is usual in the Neanderthal skulls of Europe. In modern skulls the height of the vault above the *g-i* plane is usually 50–52 per cent. of the *g–i* length and in this Skhūl V is quite modern, the vault height being 52·6 per cent. of the *g–i* length. Unfortunately Schwalbe introduced an elaborate and unnecessary series of indices and angles for measuring this feature of ancient skulls—height of vault. If any one should desire to work these out for the Mount Carmel crania, he or she will find it possible to do so from the drawings reproduced here, particularly from that given in Fig. 167.

The cranial height measurements of Skhūl V are given in Table LXXV (p. 296), with the lengths and widths in Tables LXXIII, LXXIV (pp. 295–6). Another height measurement—the basi-bregmatic—is important and must be mentioned. The basi-occipital is not quite intact, a fragment having been broken from the anterior margin of the foramen magnum, the missing part being about 5 mm. in extent. Our estimate for the basi-bregmatic height is 129 mm., a low measurement when the auricular height is taken into consideration. The basi-bregmatic height in La Chapelle is 131 mm., in Le Moustier, 128·5 mm., practically the same as in Skhūl V. In skulls of modern peoples the basi-bregmatic height may exceed the auricular height by as little as 6 mm. or by as much as 26 mm. The excess is 8 mm. in Skhūl V. This low amount is due to the basion being situated at a high level, owing to the base of the skull being short and flat; such features are not primitive, but the opposite. The length-height index is 67·1; it is technically a low chamaecephalic skull. The height represents 90·2 per cent. of the width; in this respect it is tapeinocephalic.

CRANIAL CAPACITY AND THICKNESS OF CRANIAL WALL

We have discussed the chief measurements, length, breadth, and height; others are given in Tables LXXIII–LXXV (pp. 295–6) and will be discussed presently. Meantime

we must examine the chief function of the cranial part of the skull, its brain-containing function, as indicated by its volume and the shape of the cavity. The length of the brain space measured from the extremity of the right frontal pole to that of the right occipital pole is 168 mm. The length of the skull being 192 mm., the amount of bone entering into the long diameter is therefore 24 mm., representing 12·5 per cent. of the maximum length. Now in modern skulls (Keith, 1925, vol. ii, p. 386)[1] bone forms about 8 per cent. of the total length, so that if we are to apply to this ancient skull a formula employed to obtain the cranial capacity of modern skulls we have to deduct 4·5 per cent. of its length —8·6 mm. Incidentally it may be noted that the bone proportion in the Neanderthal skulls of Europe is usually about 16 per cent., 3·5 per cent. more than in Skhūl V, and in the Rhodesian skull bone forms 19·6 per cent. of the maximum length.

Skhūl V is directly comparable with modern crania as regards the proportion of bone entering into the maximum width. At the site of maximum width the parietal bones have a thickness of 4·5 mm.; the maximum width of the cranial cavity is 134 mm. It will be noted that the width of the cavity is 80 per cent. of its length; if we consider the cavity apart from its containing wall Skhūl V falls into the brachycephalic group.

There is no need to make any reduction in the height when calculating brain volume. Along the vault the upper frontal and the whole of the parietal arc varies between 4·5 and 6·5 mm. in thickness. If, then, we use these corrected measurements with Pearson's formula for estimating the cranial capacity of modern races (Martin, 1928, vol. ii, p. 647), we obtain the following result: L. $183{\cdot}4 \times$ W. $143 \times$ A.H. $121 \times 0{\cdot}000365 + 359{\cdot}34 =$ 1,518 c.c. Owing to the peculiar formation of the skull—its great expansion in the post-auricular half—we regard this volume as an under, rather than as an over-estimate. This volume, 1,518 c.c.,[2] is above the average for European males but falls below some of the estimates for European Neanderthalians, that of La Chapelle being estimated at 1,626 c.c. by Boule.

It is a remarkable fact that of the fossil skulls discovered in Europe, that found at Ehringsdorf in 1925 (Weidenreich, 1928; Keith, 1932, p. 325), in its height, length, width, and cranial capacity is closely similar to the Skhūl V cranium. This resemblance becomes the more interesting when it is remembered that both belong to the same phase of the Pleistocene, the Riss-Würm interglacial period. They differ in one important respect; the occipital region of the Ehringsdorf specimen has the characteristic compression from above downwards that we find in the later Neanderthal skulls of Europe. In all the Skhūl specimens the occipital region (Fig. 165) is full and the nuchal area is strongly convex, not flattened.

We shall describe the endocranial conformation in more detail when dealing with the casts taken from the interior of the skulls, but here we shall touch upon some of the most important features. One which we have just mentioned, the fullness with which the cerebellar fossae appear in the nuchal region, is one of the most striking. It is particularly noticeable in the Skhūl child (Skhūl I) (Fig. 219). The lobes of the cerebellum are set low and are wide apart. In Skhūl V the floor of the cerebellar fossae is thin, only 2 mm. in thickness. If we measure the distance from the most prominent point of the cerebellar convexities to the point on the vertex cut by the mid-auricular plane, the distance in

[1] Weinert's observations are given as well as those of the author.

[2] The actual cast taken from the cavity displaced only 1,450 c.c. of water.

Skhūl V is 150 mm.; the same measurement is 123 mm. in La Chapelle, 129 mm. in the La Quina adult, and only 118 mm. in the Gibraltar skull.

We have indicated in Fig. 167 some of the more important relationships of the brain to the cranium of Skhūl V. The first of these is the depth and extent of the temporal fossae. It will be seen that the infra-temporal crest has a peculiar relation to the zygomatic arch (Fig. 171 A); instead of being on a level with the upper border of the arch, or below it as is usual in modern skulls, the crest rises 12 mm. above the upper border of the arch. Also, the anterior pole of the temporal fossa is a long way behind the lateral margin of the orbit (Fig. 167), namely, 32 mm., which is 5-7 mm. more than in modern skulls, but a distance which is usual in skulls of the Neanderthal type. The deepest part of the floor of the temporal fossa is only 5 mm. above the Frankfort plane and is 35 mm. below the level or floor of the anterior fossa on which rests the third frontal convolution (Fig. 167). This is 5-10 mm. more than is usual in modern or in ancient skulls.

The fossa for the third frontal convolution is very extensive. In modern skulls this fossa is more circumscribed and is usually on a level with, or higher than, the roof of the orbit. In Skhūl V, as in the Gibraltar skull, the frontal fossa is not only extensive but descends some millimetres below the level of the roof of the orbit.

Very striking is the massiveness of the buttress of bone which separates the fossa for the third frontal convolution from the temporal fossa (Fig. 167, *sb*). As this buttress lies within the stem of the Sylvian fissure we may speak of it as the Sylvian buttress. Lying within the anterior inferior angle of the parietal, it is a continuation of the fold formed by the lesser wing of the sphenoid. At its base the Sylvian buttress has a width of 15 mm. and a height of 5 mm., whereas in modern skulls, although it may be 7 mm. or more in height, it is usually narrow based and sharp edged even in the most primitive races. We regard the Sylvian buttress as an adaptation for transmitting the thrusts between the temporal muscle and the teeth.

ARCS, CHORDS, AND SUBTENSES OF THE BONES OF THE VAULT (Fig. 167)

Measurements are given in Table LXXVI (p. 296). All that we need note here is that the total sagittal arc of the vault, from nasion to opisthion, is 373 mm., 16 mm. more than in the La Chapelle skull and equal to the means for long-headed European males. The transverse arc, from porion to porion in the mid-auricular plane, measures 305 mm., which is a common measurement in male Australians. The circumference, measured so as to exclude the supra-orbital torus, reaches 523 mm.; if the torus is included, 547 mm. Skhūl V, had he worn a hat, would have taken about the same size as the modern European. Of the three bones entering into the formation of the sagittal arc, the parietal forms the largest section, 131 mm., the occipital comes next (124 mm.), the frontal being only 118 mm., even though the glabellar projection is included. The chord of the arc, measured from nasion to opisthion, amounts to 139 mm.

THE CRANIAL BASE

This is the most convenient point at which to describe the basi-cranial axis. Its outline is depicted in Fig. 167. It is complete save at the anterior border of the foramen magnum, where a small fragment has been broken away—estimated to have been 5 mm. The base is short, only 100 mm. separating the basion from the nasion (Table LXXVII,

p. 297). In length it equals the mean for skulls of male Australians. It is, however, about 24 mm. less than in the La Chapelle and the Le Moustier crania. It will be observed (Fig. 167) that the nasion is drawn inwards, below the glabella, to a degree often seen in Australians and altogether unlike the condition which prevails in the Neanderthal skulls of Europe (Fig. 171 A, B).

We record only two of the angles of the basi-cranial axis. The first is that which the dorsal aspect of the clivus—the post-pituitary part of the axis—forms with the Frankfort plane. In Skhūl V this angle is 60–62°, which indicates a degree of flexure found in modern European skulls. It is 55° or less in the Neanderthal skulls of Europe; in Gibraltar this angle measures 50°. The nearer the axis of the clivus approaches the Frankfort plane, the more primitive or ape-like is its state.

The other angle which we measured is that which the axis of the clivus forms with the ethmoidal plane. In the case of the angle formed by the clivus and the Frankfort plane, the less the angle the more primitive is the condition. In the present instance it is the opposite; the smaller the angle, the more flexed is the sphenoid and the more evolved the condition. The sphenoidal angle (Landzert's) in Skhūl V measures 117·5°. There is usually a greater flexure in modern skulls, the mean value for the angle being about 110°. This angle in the Gibraltar skull is 123°, in that of La Chapelle 135°. The basi-cranial axis of Skhūl V is modern in the degree of its flexure.

Before passing on to other matters we may refer to another method of measuring the basi-cranial axis, that of Welcker, where the apex of the angle lies on the upper surface of the pre-sphenoid at the point between the optic foramina named the sphenoidale. Welcker's angle in Skhūl V we estimate to have been about 125°, whereas the mean in modern crania is 134°, the flexure being greater in the fossil skull. In the Gibraltar skull the sphenoidal angle is 140° and in La Chapelle Boule determined it as 150°.

The great length of the basi-alveolar axis is in contrast with the shortness of the basi-cranial axis (100 mm.), and provides an index of the forward projection of the maxillary part of the face. The basi-alveolar diameter is 115 mm., representing 115 per cent. of the basi-cranial diameter. A face is said to be prognathous if the basi-alveolar diameter exceeds the basi-cranial length by 3 per cent. or more than 3 per cent. It will be noted how high Skhūl V stands in the standard of prognathism, but this is due, not to the length of the basi-alveolar measurement but to the shortness of the basi-cranial axis. In the Le Moustier cranium, for example, the basion-nasion and basion-prosthion diameters are almost equal (124 mm. and 125 mm. respectively); the skull of La Chapelle gives corresponding measurements. Skhūl V differs from the Neanderthal type of Europe in the shortness of the basi-cranial axis, and from primitive modern skulls in the great length of its basi-alveolar diameter; Skhūl V was an extremely prognathous individual.

CHARACTERS OF THE FACE AND FOREHEAD (Table LXXVIII)

Our last measurement has led us to the face of Skhūl V, so we shall turn now to the facial aspect of his skull as shown in Fig. 168. As will be seen from the illustrations (Fig. 168 and Pl. XVII C) the central part of the face has vanished and is represented by a cavity filled with matrix. The lower borders of the orbits and the roof and margins of the nose have vanished, save at one point where the left lateral margin of the pyriform aperture is preserved to a small extent (Fig. 168 *ln*). The face is wide, its bizygomatic

diameter being 145 mm., the same width as in the Le Moustier skull, 8 mm. less than in La Chapelle, but 15 mm. more than in the Gibraltar skull. Similar widths are recorded for Cromagnon and the Predmost crania. The total length of the face is in no wise remarkable; from nasion to gnathion it measures 126 mm. As will be seen from our table (Table LXXVIII, p. 297) the La Chapelle skull is longer, while Le Moustier is about the same length (124 mm.). There is nothing distinctive in the absolute measurements of the face of Skhūl V; they are measurements which can be paralleled absolutely and relatively amongst primitive living races as well as in fossil skulls. Nevertheless, the face is massive. Its length is almost 87 per cent. of its width; it is mesoprosopic or intermediate between the long- and the short-faced groups. The bizygomatic width is slightly greater than the maximum width of the cranium (Tables LXXIV and LXXVIII, pp. 296–7).

The length of the upper face measured from nasion to prosthion is 73 mm. Of this measurement we estimate that 53 mm. represents height of nose and 20 mm. the projected depth from the nasal sill to the alveolar point. The naso-alveolar length is usually very great in European Neanderthal skulls; in the La Chapelle skull it is 86 mm., in Gibraltar 78·5 mm., and in the La Quina skull 80 mm. Skhūl V is in closer agreement in its upper facial length and nasal height with the Cromagnon or Predmost type, than with the Neanderthaloid.

The measurements of the face give us very little guidance as to the racial nature of Skhūl V. It is otherwise when we come to a consideration of its anatomical characters. The forehead is crossed by a great bar of bone, the torus supra-orbitalis (Fig. 168; Pl. XVII c), similar in shape and in mass to that found in the Neanderthal skulls of Europe. The torus is not distinctive of Neanderthal man; it is found in the earliest races of Java and China, but as it is unknown in any Neanthropic race, we regard the torus as a character which excludes Skhūl V from the Neanthropic group of humanity. The width of the torus measured by callipers between its most lateral points is 122 mm.; its forward projection is seen in the vertex view in Fig. 166. The projection may be measured by the difference between the glabellar and the ophryonic length of the skull —13 mm. The thickness of the base of the torus taken at the mid-point of the upper margin of the orbit and measured from the ophryonic furrow to the roof of the orbit is 13 mm. All of these are measurements which can be found in Neanderthal skulls. The torus width is slightly greater in La Chapelle, namely 124 mm.; slightly less in the Gibraltar skull, 118 mm. The width in Skhūl V is about the same as in the Spy crania, but it is much greater than in the La Quina skull (114 mm.), the latter being remarkably narrow in both cranium and face. We know of only one Neanthropic skull in which the supra-orbital width reaches Neanderthaloid dimensions, and that is the skull from the Grottes des Enfants which Verneau proposed to use as a representative of the Cromagnon type. The male skull from Predmost (No. 3) has a supra-orbital width of 117 mm., and measurements of 112 mm. and more are not uncommon in robust skulls of male Australians. In none of these ancient or modern Neanthropic skulls, however, does the supra-orbital element of the torus remain intimately fused with the medial or supra-ciliary element; in Neanthropic skulls the whole lateral or supra-orbital element has undergone a downward dislocation, the functional meaning of which we shall attempt to explain later. Neither in Skhūl V nor in any of the Mount Carmel specimens is there any indication of this dislocation. We can see a shallow groove, beginning at the supra-orbital

notch, which in Skhūl V is wide and shallow and passes obliquely outwards and upwards between the medial and lateral elements.

Of the various comparisons which we have instituted between the forehead of Skhūl V and that of other races known from fossil remains, that which is the most instructive is with the frontal bone discovered in 1925 by Mr. Turville Petre in a cave to the north-west of the Sea of Galilee. The archaeological evidence indicates that the Galilee and the Mount Carmel people are not far removed in time; their caves are only 35 miles apart in space. The torus of the Galilee frontal is 119 mm. in width. Although not as wide as that of Skhūl V, its forward projection and thickness (height) are slightly greater. We shall see, too, that they differ in the sagittal contour of the glabellar region. The Galilee torus gives the impression of being an earlier and more robust stage of the form seen in Skhūl V.

When one of us came to describe the Galilee frontal bone (Keith, 1927, 1932), it was inferred that its sagittal arc being about the same as in the Gibraltar skull, the height of the arch above the Frankfort plane would also be the same. When the bregma was raised to a height of 98 mm. above the plane, as in the Gibraltar skull, the optic foramen and adjacent parts were thrown out of position; it was necessary to raise the bone about 20 mm. more, so that the bregma had a height of 118 mm. before the parts within the orbit assumed a normal position. Such a height indicated that the Neanderthaloid type of Palestine differed in this respect from that of the Neanderthal type of Europe.

The frontal of Skhūl V is also high, the bregma being 117 mm. above the Frankfort plane (Fig. 165). The Skhūl and the Galilee frontals are compared in Fig. 169, and there can be no doubt as to their similarity. Both rise about the same distance above the Frankfort plane, and the frontal angle (Fig. 172) is also about the same. The Galilee frontal was given a frontal angle of 64°; the frontal angle in Skhūl V is 63° (Table LXXVII, p. 297), while it is only 55° in the Gibraltar skull and 54° in Spy I. The inclination of the Palestinian frontal bone is not due to a slope in the frontal lobes of the brain, but to the great forward projection of the supra-orbital torus. The sagittal arc of the Galilee frontal is 125 mm., that of Skhūl V only 118 mm. (Table LXXVI, p. 296), but the parietal arc is long (131 mm.). As may be seen from Fig. 169 the frontal of Skhūl V has a slightly greater transverse diameter (Table LXXIV, p. 296). The minimum frontal diameter in both is under 100 mm. (Skhūl V, 99 mm.; Galilee, 97 mm.), whereas in the European Neanderthals this measurement is usually well over 100 mm. Even the Gibraltar skull has a minimal width of 107 mm. This width or lack of width depends upon two factors: the size of the frontal lobes of the brain, and the degree to which the temporal muscles invade, or fail to invade, the region of the temple. The difference between the minimum frontal and the supra-orbital (upper facial) widths is an indication of the degree to which the muscles of mastication are developed. In Skhūl V the difference is 23 mm., in Galilee, 22 mm., in Gibraltar, 11 mm., in La Chapelle, 15 mm., in Krapina C., 19·5 mm., Cromagnon (the Old Man), 12 mm., male Australian, 9 mm., Predmost No. 3, 13·3 mm. The large difference between the supra-orbital and minimal diameters of the frontal bone is a character of our ancient Palestinians.

The Skhūl V and the Galilee frontal bones, and the brain contained therein, were not wide. The maximum width of the frontal (Table LXXIV, p. 296) in Skhūl V is 114 mm., in Galilee, 113 mm. In European Neanderthals the greatest frontal width is usually

about 120 mm. or more; in the skulls of Englishmen the mean is 122·3 mm. The La Quina skull, which is exceptionally narrow in all parts of the cranium and face, has a maximum frontal diameter of 116 mm. A comparison of the transverse diameters of the frontal region of Skhūl V with those of the parietal region has yielded no distinctive feature.

REGION OF THE CHEEK

We now proceed to consider the region of the malar and the region of the temple and the cheek of Skhūl V. These features are depicted in Fig. 169, but before comparing the Mount Carmel individual with the specimen from Galilee it will be well to note certain features of the cheek which serve to distinguish Neanthropic peoples from the ancient peoples of Palaeoanthropic or Neanderthaloid type. We shall begin our comparison of these contrasted sets of characters at the maxilla and proceed towards the forehead. The malar process (Fig. 170 A, *mp*) in the Gibraltar skull is shaped as in an ape; it is directed obliquely upward and outwards to end in the cheek bone. In all modern races of mankind the malar process is bent as shown in Fig. 170 B. Also, with this change in direction, there is a collapse of the anterior wall of the sinus maxillaris with the production of a deep suborbital fossa. As may be seen from Fig. 169 A, B the malar process retained the Palaeoanthropic (simian) form in both the Skhūl and the Galilee skulls, but in Skhūl V there is an incipient degree of curvature.

The Palaeoanthropic malar has several other distinctive features. These are brought out in Fig. 170. The Palaeoanthropic malar, as seen in the Gibraltar skull, has a small body but a large ascending (orbital) process; the Neanthropic malar, as seen in the Australian skull, has a large body and a relatively small ascending orbital process. It will be seen from Fig. 169 that the malar of Skhūl V and of Galilee has Palaeoanthropic features, yet the Skhūl V specimen does show an approach to the modern state (Figs. 168, 169 A). If we measure the vertical height of the malar, from the highest point of the fronto-malar suture above to the lowest and most lateral point of the malo-maxillary suture below, we find that over 60 per cent. of this measurement lies above the Frankfort plane in cheeks of Palaeoanthropic races, less than 60 per cent. in Neanthropic races. The ratio in Skhūl V is Palaeoanthropic.

ZYGOPROPTOSIS

The changes which we have described in the malar region of the skull are associated with another change already noted—the separation and depression of the lateral (supra-orbital) part of the torus. All the correlated characters, the degression of the lateral torus, the bending of the orbital process of the malar on the body of the bone, the growth of the body and the bending downwards (caudally) of the malar process of the maxilla, are brought out in the facial parts of a male Australian (Fig. 170 B). All of these changes we propose to designate with the name zygoproptosis—a falling down of the os zygomaticum. We are presuming that the primitive human condition is that seen in the Gibraltar skull and in other Palaeoanthropic skulls. In this respect Skhūl V and Galilee are Palaeoanthropic, and yet we seem to see in their cheeks the beginning of the metamorphic process which we have called zygoproptosis. Its nature is discussed later (p. 365 under 24).

CURVATURE OF THE MALAR

The bending or curvature of the malar is best described in connexion with the lateral view of the temporal region depicted in Fig. 171. The degree of bending of the lateral orbital process in the Neanthropic skull is realized if the Galilee malar is compared with that of the Australian (Fig. 171 C, D). There is also an acute flexure of that part of the body of the bone which lies lateral to the malo-maxillary suture in the Neanthropic cheek. Further, the surface of the Neanthropic malar is directed more laterally than in the Palaeoanthropic type.

TEMPORAL REGION

A diagram of the arrangement of parts in the temporal region of Skhūl V is shown in Fig. 171 A, but before describing the many peculiarities which it presents, it will be best to introduce our description by first examining the arrangement of parts in a typical Palaeoanthropic skull such as that of Gibraltar (Fig. 171 B). In the drawing of that skull a horizontal double line (*X–Y–Z*) is seen passing from the margin of the orbit to the posterior border of the great wing of the sphenoid. It is drawn parallel to the Frankfort plane and 15 mm. above it. The line crosses only two bones, the malar and the ali-sphenoid. This line measures 40 mm. in the Gibraltar skull; in the Australian 26·5 mm. Both the malar (*X–Y*) and the sphenoid (*Y–Z*) elements are curtailed in the Australian skull, and it will be noted that the suture between the squama of the temporal and the great wing of the sphenoid is more convex in a forward direction, as if the squama had grown forward and suppressed the great wing and the orbital plate of the malar. There has been a retreat of the malar towards the ear for, as may be noted in our drawings, the orbital margin of the Gibraltar malar is 74 mm. in front of the vertical auricular plane, whereas in that of the Australian malar it is 69 mm. The length of the line (*X–Z*) in the Galilee skull is 39 mm., almost the same in Gibraltar, and in Skhūl V it is 37 mm. The ali-sphenoid has a great width and has similar articulations in Skhūl V, Gibraltar, and Galilee.

There are two remarkable features in the temporal region of Skhūl V. The first of these concerns the origin of the lateral head of the external pterygoid muscle (Fig. 171 A, *ept*). This head does not appear on the lateral aspect of the great wing in modern skulls, nor, for that matter, in the Gibraltar skull. The infra-temporal crest bounds the upward extent of its origin. But in Skhūl V the origin of this muscle makes a wide and deep excavation on the lateral aspect of the great wing. It is interesting to note that there is an incipient stage of this extension in the Galilee sphenoid (Fig. 171 C). This is further evidence of our contention that, despite certain robust and primitive features, the Galilee skull represents the same race as do the Mount Carmel people.

The other feature to be noted is the height of the infra-temporal crest above the zygomatic arch. It rises 12 mm. above the upper border of the arch in Skhūl V, whereas in modern skulls it is usually below the level of the upper border. There has been a certain degree of crushing in of the temporal region of Skhūl V but this peculiar feature is not due to post-mortem deformation. In brief, we find opposite conditions in the floor of the temporal fossa of human skulls—one in which the great wing of the sphenoid is 'wide-winged' or macro-sphenoid, and another in which the opposite tendency is manifest—'narrow-winged' or micro-sphenoid. The macro-sphenoid condition holds for the Palaeoanthropic races, the narrow-winged for Neanthropic races.

This is the proper place to call attention to another character which appears to be peculiar to Palaeoanthropic skulls. This is the ridging found in the temporal fossa along the suture line which marks the union of the great wing with the orbital plate of the malar. A parallel ridge separating two grooved surfaces descends on the temporal aspect of the orbital plate of the malar. These are particularly well marked in the Gibraltar and the Galilee crania. The junctional region is not preserved in Skhūl V, but the parts which remain indicate the presence of these malo-sphenoid ridges.

The intracranial aspect of the sphenoid we shall describe fully in connexion with the interior of the skull. There is one point in the structure of the sphenoid, the size and character of the post-foraminal process, which probably forms a part of the complex of characters we have discussed in the foregoing paragraphs. The Palaeoanthropic sphenoid has certain peculiarities which distinguish its intracranial aspect from that of modern races. Skhūl V shares these Palaeoanthropic characters with the Galilee specimen and both have a resemblance to the sphenoidal features found in the Gibraltar skull. (Figs. 179, 180; Pl. XVIII.)

SQUAMA OF THE TEMPORAL

The upper border of the squama of the temporal bone in Neanderthal skulls is lower and less curved than is usual in Neanthropic crania. In the Gibraltar skull, for example, the squama at its highest point is 34 mm. above the Frankfort plane; this represents 33 per cent. of the auricular height (103 mm.). The highest point of the squama in an Australian, representative of modern primitive races, is 46 mm. above the Frankfort plane, representing 38·6 per cent. of the auricular height. In the La Chapelle and the La Quina skulls, the squama height in the first is 41 mm., in the second 40 mm., the former being 35·9 per cent. and the latter 36 per cent. of the auricular height. The height of the squama in Skhūl V is 52 mm., the auricular height 121 mm., the squama height representing 42·9 per cent. of the auricular. In a high-vaulted English skull the height of the squama is 50·5 mm., its proportion to the auricular height being 43·8 per cent. Thus in the development of its temporal squama Skhūl V is Neanthropic or modern.

FACE IN PROFILE

Certain characters of the face have already been touched upon in dealing with the basi-cranial axis (p. 235). We found that the length from basion to nasion in Skhūl V was 100 mm., while the basi-alveolar distance was 115 mm., giving the very high index of prognathism of 115. The facial profile is perhaps the best of all the indications of race. Our mode of registration is illustrated in Fig. 172, where we compare the profile of Skhūl V with that of the famous member of the European Neanderthal group, the man of La Chapelle. Two base lines are employed, a horizontal, the Frankfort plane, and a vertical, the mid-auricular plane. The measurements registered (Table LXXIX, p. 297) are explained in the legend to Fig. 172.

The three angles of the face depicted in our illustration are (1) the frontal angle (similar to Martin, 32*a*, but with the Frankfort plane substituted in place of the glabello-inion line as a base), (2) the upper facial angle (Ganzprofilwinkel, Martin, 72) and the chin angle (Martin, 79 (1)), all measured on the outline drawing. The frontal angle is 63° in Skhūl V, almost the same angle as was previously assigned to the Galilee skull (64°). This angle

is 57° in La Chapelle, in the Gibraltar skull 55°, in the Predmost male 76°, in the Cromagnon type (Grottes des Enfants) 75°. The forehead of Skhūl V, in spite of his prominent torus, is less sloping than is usually the case in European Neanderthals.

As is to be expected from his projecting muzzle, the upper facial angle in Skhūl V is low, 73·5°. This angle measures 88° in the Gibraltar skull, in La Chapelle 82°, in Predmost (No. 3) 86°, in the Cromagnon cited above 83°, in an Australian 80·5°. It is among Australoid (and Negroid) living races that we find a degree of prognathism equal to that of Skhūl V.

The chin angle is shown in Figs. 172, 173. That of Skhūl V is 63°, almost the same as in the La Chapelle specimen, which is 61°. It is 75° in an Australian, 71° in Predmost (No. 3), and in the Cromagnon type the angle is more than a right angle, namely 99°. This is a very primitive condition in Skhūl V, particularly when we consider his muzzle angle, formed by the intersection of the upper facial and the chin axes. This is 136·5° in Skhūl V, in La Chapelle 143°, in the Australian 155°, in Predmost (No. 3) 157°, while in our Cromagnon type the face is virtually straight, 182°.

The measurements resulting from our analysis and comparison of the features of the facial profile are given in Table LXXIX (p. 297). The outstanding feature of the face of Skhūl V is the extent to which the upper and lower alveolar points project in front of the mid-auricular vertical, as compared with the distances occupied by the nasion and the pogonion. The forward projection of the nasion is so much less than that found in other early skulls, both Palaeoanthropic and Neanthropic (Table LXXIX, p. 297), that we suspected distortion in the naso-glabellar region, but we do not see how this region can be brought forwards without at the same time advancing the whole of the face. We feel certain that the deeply recessed nasion is approximately in its normal position.

Skhūl V was flat faced. This is best measured by the distance which the nasion lies in advance of the lateral orbital point (Figs. 172, 172, *lo*). This distance is 15 mm. in Skhūl V, 22 mm. in Galilee, 27 mm. in La Chapelle, 26 mm. in Gibraltar, 26 mm. in the Australian, 21 mm. in Predmost, 22 mm. in the Grottes des Enfants male, and 21 mm. in the Old Man of Cromagnon. Skhūl V stands nearer to the early Caucasoids of Europe in flatness of face than to the European Neanderthalians.

The same feature may be measured by means of the naso-malar angle (Martin, 77). This angle is 156° in Skhūl V, 159° in Galilee, 140° in La Chapelle, 134° in Gibraltar, 160° in the gorilla, and 127° in an Australian. Flatness of the upper face is a primitive or simian feature.

The difference in length between the glabellar and the nasion horizontals gives a measurement of the degree to which the glabellar region overhangs the root of the nose. This difference in Skhūl V is 10·5 mm. while in Galilee it is only 3 mm., the same as in the Gibraltar skull. It is 7 mm. in La Chapelle, 5 mm. in La Quina, 2·5 mm. in Krapina C, in our Australian skull 7 mm., and in Predmost 8 mm. The deep recession of the root of the nose must have given Skhūl V a characteristic appearance in which he differed from the Neanderthals of Europe and also from the Galilee individual.

The difference in length between the glabellar horizontal and that drawn to the ophryon gives a measure of the depth of the sill above the torus. In La Chapelle this difference is great, 15 mm., in La Quina it is 11 mm., in Skhūl V 8·5 mm., in Gibraltar 8 mm., in the Australian 3 mm., and in the Predmost male (No. 3) 9 mm. This last is the greatest

amount observed in a Neanthropic skull and is slightly greater than the measurement in Skhūl V.

The forward projection of the mouth and jaws is relatively great if we take the nasion horizontal as our base line. With the skull set in the Frankfort plane, the prosthion is 21 mm. and the infradental 15 mm. in advance of the nasion. The respective projections beyond the nasion are 9·5 and 5 mm. in the Australian skull which we have used as a representative of modern prognathous races. These figures in La Chapelle are 11 mm. and 3 mm.; in Gibraltar the prosthion is only 3 mm. in advance, while in Predmost it is 6 mm. in advance of the nasion, and the infradental 2·5 mm. Skhūl V was thus altogether peculiar in the projection of the lower face as compared with the upper. Yet when we measure the absolute projection of the jaws from the mid-auricular plane Skhūl V does not stand alone (Table LXXIX, p. 297). The forward projection of the prosthion in him measures 110 mm. against 117 mm. in La Chapelle, 103 mm. in Gibraltar, 112 mm. in La Quina, 106 mm. in Predmost, 109 mm. in the Old Man of Cromagnon, and 106·5 mm. in the Australian. In this character Skhūl V exceeds only to a slight degree measurements found in Neanthropic skulls, ancient and modern.

The forward projection of the chin, especially in relation to the degree of alveolar projection, determines a striking feature of the human countenance. The chin (pogonion) projection in Skhūl V is 88 mm. in front of the mid-auricular plane, 22 mm. less than is the prosthion. The retrocession of chin in the La Chapelle man was equally great; its projection, 94 mm., was 23 mm. less than the upper alveolar. In our Australian the projection was 96 mm., 8 mm. more than in Skhūl V, but it is only 10·5 mm. less than the upper alveolar length. The projection of chin in the Predmost male was 94 mm., 14 mm. less than the upper alveolar. Then, in our typical Cromagnon (the Grottes des Enfants male), the chin has reached a full, modern projection; it is 108 mm., which is slightly greater than the upper alveolar projection. Thus, in the examples cited, we have a full range of the development of the lower face, from an almost simian stage in La Chapelle and in Skhūl V to a full European development.

Another of our measurements worthy of note is the forward projection on the cheek of the attachment of the masseter muscle as indicated by the lower end of the malo-maxillary suture (zygomaxillare). The measurements are given in Table LXXIX (p. 297), that of Skhūl V is 74 mm., 2 mm. greater than in La Chapelle, 4 mm. more than in La Quina, 5 mm. greater than in Gibraltar, only 1 mm. more than in the Australian, and 6 mm. less than in the Predmost male and the Old Man of Cromagnon. The forward extension of the masseter is a feature of Neanthropic man; we seem to see the beginning of this movement in Skhūl V.

The lateral projection of this point also goes into the making of the facial features. The bimaxillary diameter (Table LXXVIII, p. 297) is great in Skhūl V. It is 110 mm., the same as in the La Chapelle skull, 7 mm. more than in Gibraltar, 13 mm. more than in the Australian, but only 1 mm. more than in the Cromagnon type.

One other measurement must be noted—that which registers the forward projection of the lateral boundary of the nasal aperture. The lateral nasal point we take to be the point (seen in profile) nearest to the mid-auricular vertical. A fragment of the lateral pyriform wall is preserved in Skhūl V, the lateral nasal point having a projection of about 92 mm. It was 18 mm. behind the prosthion, a space which, in life, is occupied by the wings of

the narial opening in the living man. The lateral nasal projection was much greater in La Chapelle, namely 108 mm., but this is only 9 mm. less than the distance to the upper alveolar point. The difference in the Gibraltar skull is only 4 mm., so far forward has the lateral wall of the nose extended. In our Australian the forward projection of the nasal aperture is 94 mm., of the prosthion, 106·5 mm., the difference being 12·5 mm. The difference is 10 mm. in the Predmost skull and 11 mm. in the Old Man of Cromagnon. The projection of the maxilla is remarkable in Skhūl V and yet the prognathism is not due to a forward slope of the upper alveolus, for, as may be noted in Figs. 165, 172, Pl. XVII, the roots of the incisors are parallel to the upper facial angle.

THE NOSE

The greater part of the nasal region of Skhūl V has perished (Fig. 168, and Pl. XVII). All that is left to guide us is the root of the nose containing the upper ends of the nasal bones, 7 mm. in length, and the corresponding terminal parts of the ascending processes of the maxilla (Fig. 174). In addition there is the left lower lateral margin of the pyriform aperture; the root of the left canine terminates on the lateral aspect of this fragment.

It will be recalled that the upper facial height (nasion–prosthion) is 73 mm., 53 mm. of this representing the nasal height, 20 mm. the premaxillary height (Table LXXX, p. 298). The fragment of the nasal aperture is 14 mm. from the midline, and we infer that the total width was about 28 mm. The width is a little less than 53 per cent. of the estimated height, thus falling into the class of broad noses, but in the narrower range of that group. Compared to the measurements yielded by Neanderthal skulls, these of Skhūl V are relatively low. The nasal height in the Gibraltar skull is 58·5 mm., that of La Chapelle, 62·5, and the respective widths 34·5 mm. and 34 mm. The Skhūl figures are near to those found in the early Caucasoid skulls of Europe; for example, the Predmost male (No. 3) has a nasal height of 58·2 mm. and a width of 26·4 mm.

In only two Neanderthal skulls from Europe is the root of the nose intact—in Gibraltar and in Krapina C. These have the same peculiar saddle-shaped form, the bridge of the nose passing gradually into the glabellar region of the frontal, constituting the bow of the saddle (Fig. 174 C′). Two drawings of the inter-orbital region of Skhūl V are given in Fig. 174, one a front view, the other lateral. Drawings of the corresponding region in the Gibraltar and the Galilee skulls are given for comparison. The form of the root of the nose in Skhūl V is totally different to that of Neanderthal skulls. The upper ends of the nasal bones are fused, as in the Galilee man, so as to form a flat narrow plate, square-cut at the nasion, becoming slightly ridged lower down. The upper width of the nasal plate is 9 mm.; lower down on the ridged part it is only 7 mm. When viewed in profile, the nasal bones project only a little more than 1 mm. in front of the frontal process of the maxilla (Fig. 174 A′). The upper ends of the nasal bones in the Gibraltar skull are still separate, except just below the nasion, and form a transverse arch which fades into the frontal bone. Their width, at the narrowest point, is 14 mm., and their projection in profile is 4 mm. The form and the dimensions in the Galilee skull are intermediate to those of the Skhūl and the Gibraltar crania (Fig. 174 B, B′).

The nasal bones of Skhūl V are not only narrow and flat, but the whole root of the nose, dividing one orbit from the other, is flat, as we find it in many African (Negro) and Asiatic (Mongoloid) races. The bi-dacral width is 24 mm. (Table LXXVIII, p. 297) or

if we take the whole or bi-lachrymal width, 28 mm. Both are moderate amounts. That the root of the nose is remarkably flat and low is borne out by the slight degree to which the nasal bones and the frontal process of the maxilla project in front of the dacryon. This measures 6 mm. in Skhūl V, 10 mm. in the Gibraltar skull, and is slightly more than 10 mm. in the Australian which serves as a type. The bridge of the nose in an English skull has a projection of 13 mm.

Our knowledge of the nose of Skhūl V is incomplete and based on fragments, yet the evidence leaves no doubt that in his nasal characters he differed materially from the European Palaeoanthropi. Further, the nasal characters in the Galilee skull are intermediate in character, though nearer to the Skhūl than to the Gibraltar type.

THE ORBITS

We have seen that the orbits of Skhūl V were bounded above by a massive torus supra-orbitalis, in this being similar to the Palaeoanthropic peoples of Europe. Also, the malar, which forms the lateral and part of the infra-orbital border, is similar in form to that of these ancient Europeans. Unfortunately the lower and medial boundaries of the orbit in Skhūl V have perished.

Our measurements of the orbit are based upon the more perfect of the two incomplete orbits of Skhūl V, the right one (Fig. 168 and Pl. XVII). Its width from the fronto-maxillary point to the malar border is 46 mm., the same width as in the Gibraltar skull, 2 mm. more than in Galilee and Le Moustier, 1 mm. less than in La Chapelle, and 4 mm. more than in our Australian. The Neanderthal orbit is not only wide but also high; the height is 39 mm. in the right orbit of the Gibraltar skull. It was not more than 30 mm. in Skhūl V, the height thus being only *c.* 65 per cent. of the width, a relatively low orbit. The orbital height is also 30 mm. in our Australian type specimen, this being 71·4 per cent. of the width. In the Gibraltar skull the orbital height is 84·7 per cent. of the width.

The depth of the orbit in Skhūl V was apparently very similar to that of the Gibraltar and the Galilee crania. The depth of the roof in Skhūl V, measured from the lateral border of the opening of the optic foramen to the midpoint of the supra-orbital margin, is 62 mm. This measurement is 63 mm. in the Gibraltar skull, 62 mm. in Galilee, and 59 mm. in the Australian.

In the orbit, as in the nose, we find features in Skhūl V which differentiate him from the European Palaeoanthropi.

MASTICATORY SYSTEM (PALATE)

The description of that part of the maxilla which carries the teeth and forms the palate has been presented in Chapter XIII. An exact drawing of the palate is given in Fig. 133 A. The dentition being almost intact, we have measured the area of the dental palate, the area within the buccal margin of the dental arcade. This area is very large in Skhūl V (36·3 sq. cm.), being 2 sq. cm. larger than in the Heidelberg mandible and 10 sq. cm. larger than the mean for modern European males. In our Australian palate the area is 31·6 sq. cm. Not only is the Skhūl palate wide and long (Table LXVII, p. 211) but it is also deep or high vaulted. The vault rises 18 mm. above the level of the alveolar margin at the second molars, which is 3–5 mm. more than is usual in modern

palates. The internal palatal width (Martin 63) is 45 mm., its length (Martin 62) 60 mm., the width being 75 per cent. of the length and thus falling into the group of long palates. The Gibraltar skull (width index, 88?) has, as is usual in Neanderthal Europeans, a relatively wide and short palate.

If we take the outside measurements of the palate between the alveolar borders above the second molars and from the prosthion to the midpoint of a line tangent to the heels of the alveolar borders (Martin, 61, 60) the length is 65·5 mm., the width 69·5 mm., the index, 106. Skhūl V thus falls well within the dolichuranic group.

The spine of the palate is short and broad (Fig. 179). The maximum antero-posterior diameter of the horizontal plate of the palate bone is 16 mm., only 1 mm. more than in our Australian. The bone on each side of the median suture is raised to form a ridge, very similar to the condition found in modern races.

MUSCLES OF MASTICATION

With such a development of the teeth and of the palate we should expect to find evidence of a great development of the muscles of mastication. The attachment of the masseter muscle was advanced in the face (p. 236), but it will be recalled that in the mandible there was clear evidence of only a moderate development of the masticatory muscles. This is also evident in the unexpected slenderness of the zygomatic arches. If the diameters be taken at the point where the zygomatic arch is shallowest, usually 8–10 mm. in front of the articular eminence, the vertical diameter in Skhūl V is 6·5 mm., the horizontal, 6 mm. The corresponding measurements in the Australian are 8·5 × 4 mm.

As is well known, the temporal muscles extend their attachment upwards on the side of the skull with age and growth. The height to which the lower (muscular) of the two temporal lines has ascended above the level of the zygoma may be taken as an index of temporal development. Our measurements are made with a steel tape, parallel to but 15 mm. behind the coronal suture, and the distances from the upper border of the zygoma to the temporal line and from the latter to the sagittal suture are determined. On the left side of Skhūl V the lower temporal line is 115 mm. above the zygoma and 45 mm. from the sagittal suture (Table LXXXI, p. 298). This is a great temporal extension. A similar measurement in an Australian skull gives 100 mm. and 52 mm. The temporal line is 75 mm. above the level of the zygoma in the Gibraltar skull.

Another indication of the development of the muscles of mastication is obtained by comparing the infra-temporal diameter—the least width between the infra-temporal ridges on the great wing of the sphenoid—and the bizygomatic diameter. In Skhūl V the bizygomatic diameter is 145 mm., the infra-temporal, 84 mm.; the difference, 61 mm., indicates a wide muscular space. This difference in the Gibraltar skull is 59 mm. and in the Australian, 56 mm.

The comparison of the minimum frontal widths with the supra-orbital widths is another way of indicating this same feature. As was mentioned on p. 237, the difference was very great in Skhūl V.

TEMPORO-MANDIBULAR JOINT

The temporo-mandibular joint of Neanderthal man differs markedly from that of modern man and so we turn with interest to this region in Skhūl V. We may say at once

that in its main features it resembles the joint in modern races. To give precision to our description we have found it necessary to adopt new modes of measurement, and in Fig. 175 A, A′ are shown two drawings of this region in Skhūl V, a profile and a basal view, both being drawn with the skull in the Frankfort plane. The length of the joint is measured parallel to the sagittal plane of the skull from the highest (or lowest) point on the edge of the post-glenoid spine to the anterior edge of the articular surface on the eminence. These measurements are given in full in Table LXXXI (p. 298). The length in Skhūl V is 19 mm.; in Gibraltar 18 mm.; in our Australian 18 mm.; in La Chapelle 25 mm. The width we measure at right-angles to the last, from the most medial to the most lateral margin of the articular surface. The width in Skhūl V is 26 mm., in Gibraltar 22·5 mm., the same as in the Australian, and in La Chapelle it is 29 mm. This joint in Skhūl V is wide in comparison to its length.

The measurements do not help us to separate one type of joint from the other. We turn, therefore, to the relationship of the deepest part of the joint to the highest as seen in a tracing of the contour made along the middle of the joint and rendered by a broken line in Fig. 175 A, B, C (also Pl. XVIII and Fig. 179). The mandibular cavity in Skhūl V is seen to rise to the level of the Frankfort plane; the articular eminence at its midpoint lies 5 mm. below the Frankfort plane. The difference in level represents the depth of the mandibular fossa and is 5 mm. The mandibular joint in the Australian (Fig. 175 B) is more robust and also nearer to the condition found in the anthropoid apes. The roof of the fossa lies 3·5 mm. below the Frankfort plane, the articular eminence 8·5 mm., and the difference in level is the same as in Skhūl V, namely 5 mm. In the Gibraltar joint (Fig. 175 C) the roof of the fossa lies 2·5 mm. and the eminence 4·5 mm. below the Frankfort plane, the difference being 2 mm. The difference in levels in La Chapelle is 5·5 mm., and an equally great difference apparently was present in a Krapina specimen (C). The peculiarity of the Skhūl joint lies not in the difference of levels but in the steepness with which the articular eminence descends from the fossa and on the depth of the fossa in relation to the meatus and the Frankfort plane. To find a state similar to that seen in the temporo-mandibular joint we have to make a comparison with modern European skulls.

We depict also in Fig. 175 the medial boundary of the joint formed by two elements, the temporal tuberosity and the sphenoidal spine (Fig. 175, *d*). The articular element of the medial boundary of the joint in Skhūl V descends only 2 mm. below the level of the lateral border of the joint, while in the Australian the descent is 7 mm. and in Gibraltar 8 mm. The massiveness and the extent of the descent of the medial part of the articulation (*b′*) is a characteristic of all the Neanderthals of Europe. It is to be seen in the Ehringsdorf skull and those of Krapina. It is a feature which is almost absent in Skhūl V.

One of the most characteristic features of the modern (Neanthropic) skull is the form taken by the tympanic plate which forms the hinder boundary of the temporo-mandibular articulation and is intimately connected with the function of mastication. In the Australian, for example, the plate forms a single plane, sloping from the petro-tympanic fissure to a free vaginal ridge wrapt round the base of the styloid process (Fig. 175 B′, *v*, *sty*). The plate is more horizontal in the Gibraltar skull (Fig. 175 C); the vaginal ridge seems to divide the plate into two areas, one in front of the ridge and the other behind it. In modern temporal bones the posterior area has become suppressed by the extension backwards and downwards of the vaginal margin of the tympanic plate (Fig. 175 B′).

As will be seen from Fig. 175 A′, the tympanic plate of Skhūl V has assumed the modern form.

AUDITORY MEATUS

There is a corresponding change in the form of the external auditory meatus accompanying the alteration in the form of the tympanic plate. As will be seen from Fig. 175 C, the meatus of the Gibraltar skull has its greater diameter in an antero-posterior direction; in the Australian and in Skhūl V the vertical diameter is the greater. Measured at the free margin of the tympanic plate, the vertical diameter in Gibraltar is 8·2 mm., its antero-posterior diameter, 11 mm. These measurements in Skhūl V are 9 mm. and 7 mm.; in our Australian, 10 mm. and 7 mm. In the Gibraltar skull, which represents the Neanderthal type, the antero-posterior diameter is 134 per cent. of the vertical, while in the Australian the figure is 70 per cent. and in Skhūl V, 77 per cent.

THE NUCHAL REGION

Skhūl V had an exceedingly thick and massive neck, the hinder occipital wall rising directly in line with the neck, as in many modern Europeans with flat occiputs and brachycephalic heads. Our method of measuring the attachment of the neck and the various modifications the occipito-mastoid region undergoes for this purpose is shown in Fig. 176. In that figure we present for comparison with the profile of the nuchal region of Skhūl V (A), the same parts in an Australian (B), to show the condition of the parts in a robust member of a primitive modern race, and also the nuchal region of the Gibraltar skull (C). It will be observed that in the Gibraltar and Australian crania the external occipital protuberance (inion) which marks the posterior limit of the attachment of the neck lies on the Frankfort plane, whereas in the La Chapelle skull the nuchal region is so oblique that the inion lies 15 mm. above the plane. The obliquity is still more in the La Quina skull (wrongly diagnosed as that of a woman), the inion being 21 mm. above the Frankfort plane. The obliquity of the nuchal plane is an approach towards the condition seen in the anthropoid skull. In this feature Skhūl V is both human and modern, with the inion only 6 mm. above the Frankfort plane.

The distance of the inion behind the mid-auricular plane in Skhūl V is 89 mm., in La Chapelle, 91 mm., in La Quina, 86·5 mm., in Gibraltar, 79 mm., in our Australian, 69 mm., and in Predmost, 80 mm. A more exact measurement of the neck is the projected length of our *N–P* line (Fig. 176), passing from the anterior margin of the mastoid to the inion. The nuchal *a–p* diameter in Skhūl V is 85 mm., in La Chapelle, 89 mm., in La Quina, 86 mm., in Gibraltar, 72 mm., in the Australian, 65 mm., in Predmost (No. 3), 75 mm., and in the Old Man of Cramagnon, 79 mm. (Table LXXXII, p. 298). Skhūl V has one of the most powerful necks that has been met with amongst fossil mankind.

The transverse diameter of the neck is given by a bimastoid diameter measured between the insertions of the two chief muscles of the neck, the sternomastoids. These widths are given in Table LXXXII (p. 298). This diameter in Skhūl V is 130 mm., 8 mm. less than in the Rhodesian skull, 3 mm. less than in the Old Man's (Cromagnon) skull, but 5 mm. more than in Gibraltar and 7 mm. more than in the Australian. Necks differ in shape just as heads do; that of Skhūl V was thick from front to back but relatively narrow from side to side.

Drawings of the nuchal region are shown in Fig. 178 of the same three skulls as were

depicted in Fig. 176, but their basal aspects are presented at right angles to the Frankfort plane. It is easy with a sheet of glass divided into 5 mm. squares to estimate from the drawings the area thus presented. In Skhūl V it is 98·7 sq. cm., in the Gibraltar skull, 72·5 sq. cm., and in the Australian 68 sq. cm. The nuchal area in La Chapelle is approximately the same as in Skhūl V. The figures give some indication of the strength of the necks of Palaeoanthropic man.

We must return to Fig. 176 to record features of the mastoid process. An imperfectly developed mastoid is a character of Neanderthal man. As will be seen from Fig. 176 A, the mastoid of Skhūl V is modern in size and in shape; its apex descends 26 mm. below the Frankfort plane. In Gibraltar this measurement is 18 mm., in La Quina, 23 mm., in La Chapelle, 24 mm., in our Australian, 25·5 mm. There is, therefore, no real difference between Skhūl V, La Chapelle, and the Australian so far as the vertical measurement of the mastoid is concerned. The digastric fossa is exposed in a lateral view of a typical Neanderthal skull such as the Gibraltar one (Fig. 176 C, *di*), with a prominent paramastoid eminence on its inner flank, descending lower than the tip of the mastoid process. The Neanthropic condition is seen in the Australian skull (Fig. 176 B). The digastric fossa and paramastoid of Skhūl V are intermediate in conformation to that seen in the Neanderthal and in modern crania.

Another point to be noted is the convexity of the nuchal floor of Skhūl V as seen in profile, whereas that of Neanderthal skulls is remarkably flat. The convexity of the floor is best measured by using the *N–P* line as a base; the convexity in Skhūl V descends—at right angles to the midpoint of this line—17·5 mm., only 10 mm. in Gibraltar, 13 mm. in the Australian, 16 mm. in La Quina, and 15 mm. in La Chapelle.

Of the muscular impressions on the nuchal area, the most remarkable is that made by the semispinalis capitis (complexus). This is well shown in both the profile and basal views (Figs. 176, 178, *sc*). The extent of the attachment of the semispinalis is enormous. Its lateral boundary is indicated by a prominent ridge. It will be seen from Fig. 178 B and C how greatly the attachment in Skhūl V differs in shape and size from that seen in either the Gibraltar or the Australian skulls. It would take us too far afield to describe the other muscular impressions; the anatomist will be able to distinguish them in our drawing.

TORUS OCCIPITALIS

Before describing this feature it is necessary first to say something about its nature. It is exactly of the same nature as the bone wave which moves up the parietal bone in advance of the growing temporal muscle and which, when full growth is reached, forms the upper and lower temporal lines. The torus occipitalis is the wave of bone which precedes the expanding insertion of the semispinalis capitis and also the trapezius, although the latter is a minor factor. As is well known, the brain and cranial box expand at a much earlier period than the neck; the relatively small neck and big head of boyhood is familiar to all. As the neck grows in late youth, the torus occipitalis moves upwards. If the profiles we have given in Fig. 176 be compared, it will be seen that in the Australian growth of neck has been arrested at almost a juvenile stage, whereas in Skhūl V and in Gibraltar the growth has gone on until the torus has reached the posterior limit of the basal aspect of the occipital and has become flush with the posterior and vertical aspect

of the occipital bone. But the occipital wave which precedes the semispinalis in Neanderthal skulls differs in form and in mass from that seen in modern skulls by being more rounded and massive. The torus in Skhūl V is intermediate in form and extent, although tending perhaps more towards the Neanderthal form. In one respect, however, the toral formation of Skhūl V is modern. In all three skulls represented in Figs. 176, 178, there is a pit or fossa above the region of the inion. The pit is really part of the virgin surface of the occipital enclosed between the upgrowing right and left occipital waves which form the torus. In the Gibraltar skull, as is usual in all Neanderthal specimens, the suprainial pit is bounded below by a bar of bone which unites right and left occipital waves. The bone which forms the lower margin of the pit in all modern crania projects downwards to form a separate unit, the external occipital protuberance (Fig. 178 B, *i*). This Neanthropic feature is already present in Skhūl V. In this, as in so many of its features, Skhūl V manifests a tendency to reproduce the features of modern man. Yet in his fundamental organization he is Palaeoanthropic.

FORAMEN MAGNUM (Figs. 178, 179; Pl. XVIII)

The dimensions of this foramen are given in Table LXXVII (p. 297); neither in form nor in dimensions do we find distinctive characters, nor is its angle peculiar. The foramen magnum in a modern skull, orientated on the Frankfort plane, slopes from before, downwards and backwards. In adult anthropoid apes with their extended occiputs, the foramen is tilted so that it slopes upwards and backwards. The foramen in the La Chapelle skull has the anthropoid tilt to the extent of $+7°$; in this respect Skhūl V is modern and human, the foramen forming an angle with the Frankfort plane of $-11{\cdot}5°$. The angle is $-14°$ in an Australian and is $-3{\cdot}5°$ in the Gibraltar cranium.

The occipital condyles of Skhūl V are shown in Figs. 176 A, 178 A. The general direction of their articular surface is downwards, outwards, and backwards. We have seen that for so massive a skull the atlas was remarkably small, and the occipital condyles are not large. The best preserved is the left, its length being 21 mm. (?), with a width of 13 mm. (?). The dimensions in the Australian skull are almost the same, but there is a difference in form, the condyle being flat and low while those of Skhūl V are convex and prominent. The relationship to the mastoid is shown in Figs. 176 A, 178 A.

OCCIPITAL ASPECT OF SKHŪL V (Fig. 177; Pl. XVII)

We have, up to this point, devoted ourselves to a systematic description of the anatomy of the skull of this remarkable man. To complete our description it is now necessary to give our attention to certain aspects of the skull we have not hitherto touched upon. First, there is the occipital view depicted in Fig. 177 and Pl. XVII D, the skull being orientated in the Frankfort plane. This aspect of Skhūl V is quite unlike that of any of the Neanderthal skulls of Europe. It is not compressed from above downwards and rounded on the sides as these are, but is compressed from side to side as is the case in most Neanthropic crania. The height, if we measure from the level of the opisthion, is 143 mm., exactly the same as the major width. If we measure from the basion, then the height, 129 mm., is 90·2 per cent. of the width. These measurements, absolute and relative, are frequently found in modern skulls.

The drawing (Fig. 177) shows the extent to which the skull has been deformed by earth

pressure. The region of the left ear is pressed inwards and upwards so that the meatus is situated 5 mm. higher up and farther forwards than the right ear, which we regard as normal.

It is usual, both in Palaeoanthropic and Neanthropic human crania, to find that the region of the left occiput containing the left occipital pole of the brain projects a millimetre or more farther back than the right occipital pole. The degree of projection is equal in Skhūl V and although the fossae within, which lodge the occipital poles of the brain, differ in shape and depth the one does not seem to preponderate in size over the other. A similar asymmetry can usually be detected in the form of the lambdoid suture, that of the left side being the farther from the midline and the longer. A glance at our drawing will show that the left half of the lambdoid makes a slightly wider sweep than the right. If we regard preponderance of the left occipital pole as a sign of righthandedness, then we must infer that Skhūl V was ambidextrous. Our drawing also shows the development of the upper and lower occipital lines, marking the torus, and an incipient external occipital protuberance. The large mastoid emissary vein will be noted in all our drawings.

BASAL VIEW OF SKHŪL V (Fig. 179)

In Fig. 179 we give a drawing of the base of this skull, drawn at right angles to the Frankfort plane (also Pl. XVIII). Most of its parts have been described in our systematic account, but some others of importance we have scarcely touched upon. There is no skull of this early date in which the basal parts have been preserved so completely; hence our comparison, in the main, must be with modern skulls.

Fortunately the alveolar plane of the palate lay almost in the Frankfort plane so that measurements can be made from the drawing of all parts relating to the palate and teeth. The naso-palatine canal (A) is wide, with a rounded, sloping anterior wall. The openings of the posterior palatine canals (B) are preserved; the transverse cleft corresponds to the palato-maxillary suture. There is a low median sagittal palatine crest (D); the palatal spine is 5 mm. long and wide-based. The posterior nasal openings (choanae) are filled with breccia, left to support the somewhat fissured palatal floor. The base (vaginal process) of the vomer (G) is shown.

The zygomatic arches are intact; the acute bend or angle where the zygoma joins the maxillary process must have formed a marked prominence in the cheek. Such an acute angle is Neanthropic, not Palaeoanthropic.

There are certain features of the sphenoid that are worthy of note. The foramen ovale (K), triangular rather than oval in shape, has a very deep, rounded anterior wall, 7 mm. in thickness. Its massive wall is due to the fact that the sloping base of the lateral pterygoid process, also rounded and strong, ends on the anterior margin of the foramen. The foramen for the middle meningeal artery is situated lateral to the spinous process of the sphenoid.

Still more remarkable is the posterior wall of the foramen ovale. It is formed by a wide laminar process of bone which, arising from the lateral margin of the carotid groove, passes out behind the foramen ovale and along the groove which lodges the tympanic tube and ends as the spinous process of the sphenoid. The foramen for the meningeal artery is formed in the posterior aspect of the spinous part of the process.

So far as we can learn this laminar process (Fig. 175, *pf*) has not been recognized as a separate element by human anatomists; the structure described as the lingula is part of its base; we propose to name the whole the post-foraminal process. It is best seen within the skull where its upper edge bounds the opening for the internal carotid artery, its lower forming the posterior border of the foramen ovale (Fig. 180). The width of this process at its base is 14 mm.

When reporting on the sphenoid of the Galilee skull one of us (A. K.) described the foramen ovale as a notch on the posterior margin of the great wing. We are now convinced that there had been a post-foraminal process in that bone which had been broken away, leaving the basal part, the lingula, with so smooth a margin that it appeared as if it were an intact process. The Galilee sphenoid shows the same characters as Skhūl V with one exception: in the Galilee bone the sphenoidal sinus was extended into the pterygoid process. Unfortunately neither the outer nor the inner pterygoid plates are complete in Skhūl V.

On the under surface of the petro-mastoid are some structures which need mention. On the right side the styloid process (Fig. 179 S) is preserved. It is 20 mm. long and the diameter at the mid-point is 2·5 mm. Behind and lateral to the base of the styloid and vaginal process is the opening for the facial nerve. The opening for the carotid artery lies behind and is partly covered by the vaginal process. It is oval in shape, 6·5 mm. × 5 mm. in diameter. The right jugular foramen is the larger. All the markings in the petro-mastoid region are as in modern skulls.

The basilar process of the occipital is also shown in our drawing (Fig. 179). A piece, about 5 mm. in extent, is broken away at the anterior margin of the foramen magnum. The length of the process from the base of the vomer to the position of the basion is 26 mm. Its width between the apices of the petrous bones is also 26 mm. These measurements do not differ materially from those found in robust modern skulls.

INTRACRANIAL FEATURES (Fig. 180)

Another aspect of the skull of Skhūl V is presented in Fig. 180 and Pl. XVIII. The loose fragment of the calvarium has been removed, exposing the intracranial aspect of the base from the frontal sinuses anteriorly to the foramen magnum behind. How much the anterior internal part has been crushed and eroded will be seen from the drawing. The areas covered by oblique lines are those which have perished and are represented now by hard breccia. The ethmoidal region with its crista and plates has disappeared (Fig. 180, D). The floor of the right frontal sinus is exposed (A) and part of the left is also seen. The interfrontal septum is preserved, and is situated slightly to the left of the midline. The midline is indicated by a fragment of the median frontal crest; it is seen on the inner side of the left frontal pole (B). Two parts of the right frontal pole are preserved (C). Fragments of the orbital roofs are preserved at E, E. Fortunately parts of the lesser wings of the sphenoid are preserved at F, F. There is a distinct trace of the left optic foramen; on the right the position of the foramen is less certain. In any case, the middle part of the base of the skull, so much of which has been replaced by hard earth, is crushed and flattened from above so that the optic foramina have been forced apart. The right lesser wing has been separated from its lateral continuation, the Sylvian crest,

and the course of its hinder margin is somewhat uncertain. Part of the wide impression for the third frontal convolution is shown at G.

The fossa for the pituitary must have been wide and shallow (H); along the lateral margin of the fossa is the groove for the internal carotid artery (J). Still more lateral is a deep and wide groove for the infra-orbital division of the Fifth nerve, the groove passing forwards from the foramen ovale (K). The internal carotid enters the interior of the cranium by a round foramen with complete bony walls (M), formed in three-fourths of its extent by the sphenoid (including the post-foraminal lamina; p. 251) and the apex of the petrous.

Nothing can be said about the anterior or posterior boundaries of the pituitary fossa; they have disappeared. One notes, however, that the basilar process of the occipital and the body of the sphenoid are continued into each other on the medial margin of the carotid foramen. There was a large inferior petrosal sinus; at least its groove is wide and deep.

The share taken by the great wing of the sphenoid in forming the floor of the middle fossa is shown in our drawing. Although the middle meningeal foramen (L) lies entirely within the sphenoid on the outer basal aspect (Fig. 179, L), yet when the artery appears within, it lies between the sphenoid and the temporal. The meningeal artery (Fig. 180) divides into anterior and posterior branches. The posterior branch passes backwards in the petro-squamous sinus. The groove for the great superficial petrosal nerve is clearly demarcated (Fig. 180, P).

There is not a single feature in the intracranial aspect of the petrous of Skhūl V which serves to distinguish the bone from a modern bone. It is otherwise in the Gibraltar skull. There the two surfaces—anterior and posterior—fade into each other; there is no sharp ridge formed between them; the internal auditory meatus opens on to the upper surface. In Skhūl V a very sharply marked ridge separates the two surfaces, as in modern crania. The posterior surface is steep, looking backwards and inwards. The internal auditory meatus opens on the posterior surface (Fig. 180, R). The hiatus vestibuli (U) is an oblique cleft opening below the site of the posterior semicircular canal. The eminentia arcuata is not higher or more differentiated than in modern skulls. Although the right lateral sinus is the larger, the left is also well marked (Y). In the floor of the sigmoid part—just behind the hiatus vestibuli—is a wide foramen, but this we regard as artificial; it opened on the exterior of the skull just behind the jugular foramen.

On the floor of the posterior fossa are to be seen the basilar process (O), the inferior petrosal sinus (S), the opening for nerves IX, X, XI, and the jugular foramen (T). The fossa for the lateral lobes (W) of the cerebellum are deep, wide, and evenly concave. Between the cerebellar fossa, and occupying in life the space between the lateral lobes of the cerebellum, is the rounded and prominent internal occipital crest, which divides as it ends on the posterior margin of the foramen magnum (Fig. 180 *for*).

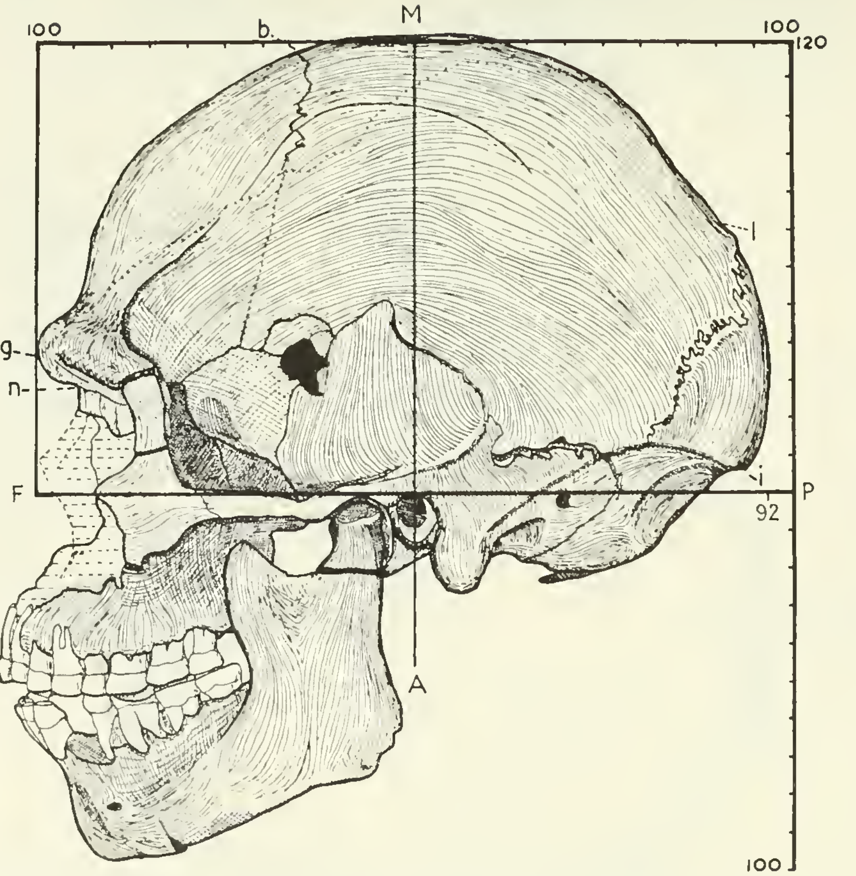
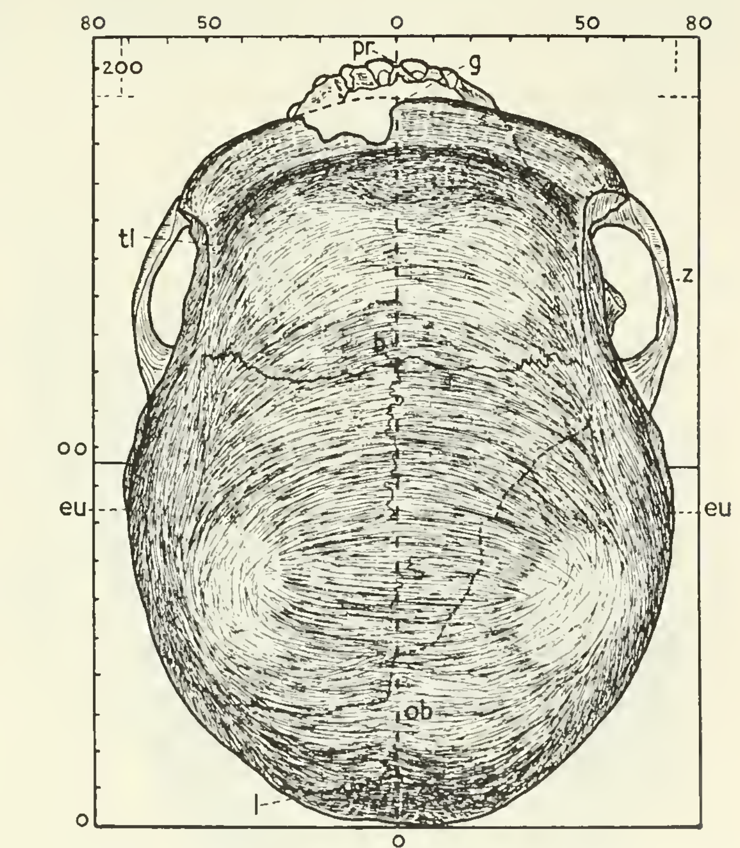


Fig. 165. Skhūl V, in Norma Lateralis (Right Side, Reversed). Orientated on the Frankfort plane (*F–P*), with a vertical line bisecting the meatus and marking the mid-auricular plane (*M–A*). The anterior and posterior verticals are placed 100 mm. in front of and behind the mid-auricular plane. An upper horizontal line is placed 120 mm. above the Frankfort plane. *n*, nasion; *g*, glabella; *b*, bregma; *l*, lambda; *i*, inion.



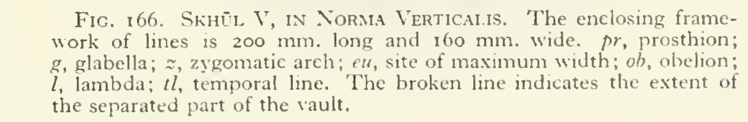


Fig. 166. Skhūl V, in Norma Verticalis. The enclosing framework of lines is 200 mm. long and 160 mm. wide. *pr*, prosthion; *g*, glabella; *z*, zygomatic arch; *eu*, site of maximum width; *ob*, obelion; *l*, lambda; *tl*, temporal line. The broken line indicates the extent of the separated part of the vault.

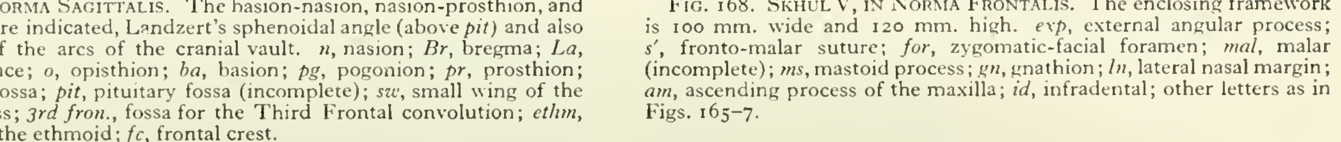


Fig. 167. Skhūl V, in Norma Sagittalis. The basion-nasion, nasion-prosthion, and basion-prosthion diameters are indicated, Landzert's sphenoidal angle (above *pit*) and also the chords and subtenses of the arcs of the cranial vault. *n*, nasion; *Br*, bregma; *La*, lambda; *ce*, cruciate eminence; *o*, opisthion; *ba*, basion; *pg*, pogonion; *pr*, prosthion; *temp*, floor of the temporal fossa; *pit*, pituitary fossa (incomplete); *sw*, small wing of the sphenoid; *sb*, Sylvian buttress; *3rd fron.*, fossa for the Third Frontal convolution; *ethm*, level of the upper surface of the ethmoid; *fc*, frontal crest.

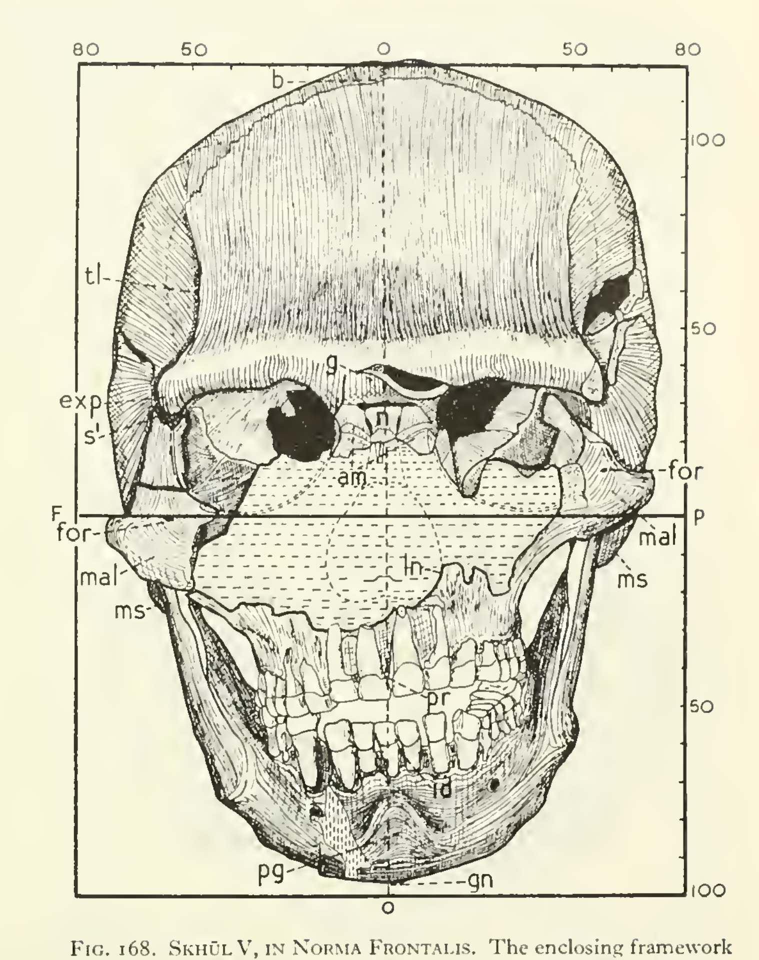


Fig. 168. Skhūl V, in Norma Frontalis. The enclosing framework is 100 mm. wide and 120 mm. high. *exp*, external angular process; *s'*, fronto-malar suture; *for*, zygomatic-facial foramen; *mal*, malar (incomplete); *ms*, mastoid process; *gn*, gnathion; *ln*, lateral nasal margin; *am*, ascending process of the maxilla; *id*, infradental; other letters as in Figs. 165–7.

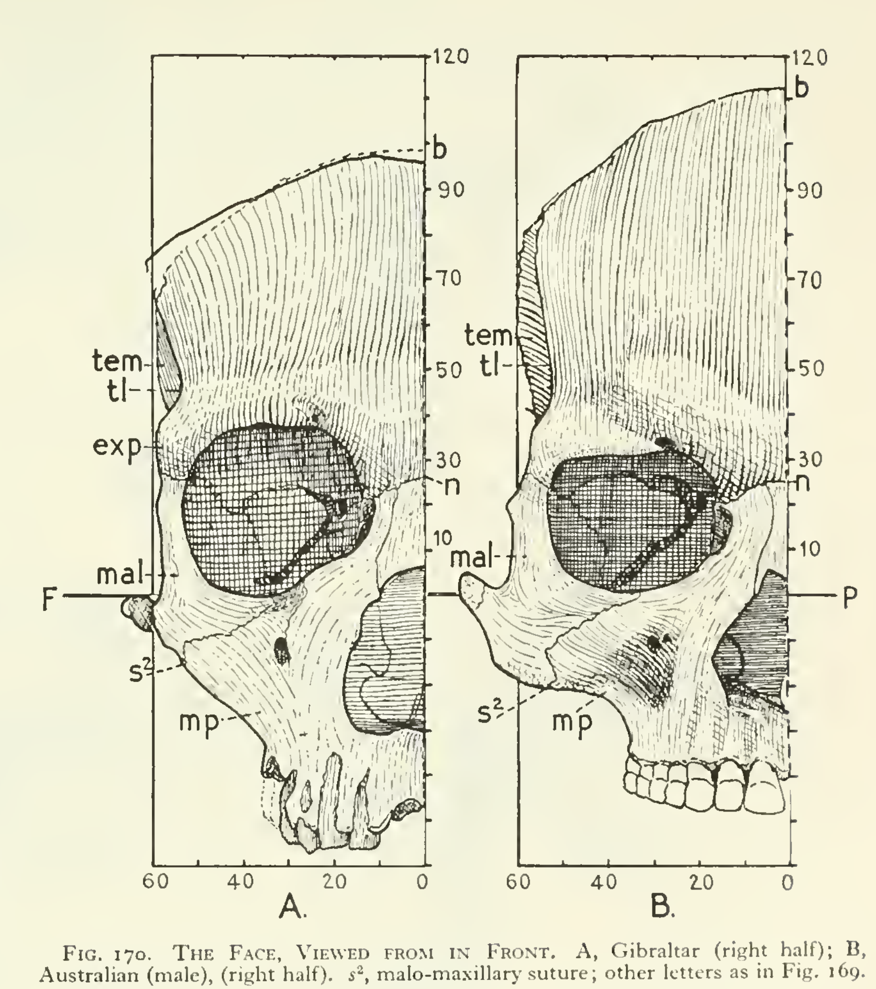


Fig. 169. The Face, Viewed from in Front. A, Skhūl V (right half); B, Galilee (right half). The parts preserved are shaded. The enclosing framework rises 120 mm. above the Frankfort plane and descends 60 mm. below it. It is 60 mm. wide and any structure touching the lateral vertical line may be considered to have a transverse diameter of 120 mm. *b*, bregma; *n*, nasion; *tor*, frontal torus; *mp*, malar process of the maxilla; *mal*, malar; *exp*, external angular process; *tl*, temporal line; *tem*, temporal fossa.

Fig. 170. The Face, Viewed from in Front. A, Gibraltar (right half); B, Australian (male), (right half). s^2, malo-maxillary suture; other letters as in Fig. 169.

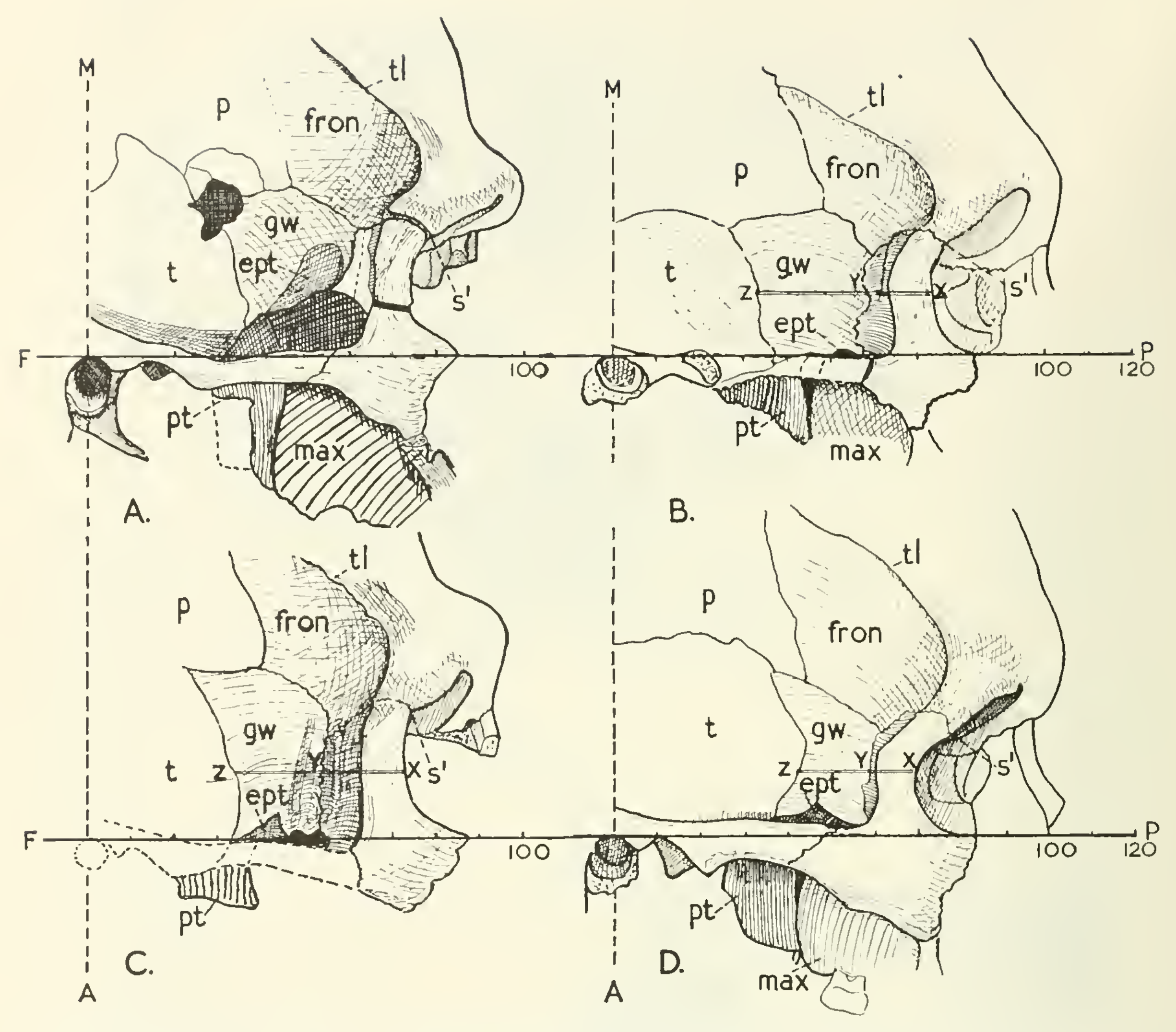


FIG. 171. THE TEMPORAL REGION. A, Skhūl V; B, Gibraltar; C, Galilee; D, Australian (male). *tl*, temporal line; *fron*, frontal bone; *p*, parietal; *gw*, great wing of the sphenoid; *s'*, fronto-malar suture; *ept*, origin of external pterygoid muscle; *t*, squama of the temporal; *pt*, external pterygoid plate; *max*, hinder part of the maxilla. *X–Y–Z*, see text, p. 239.

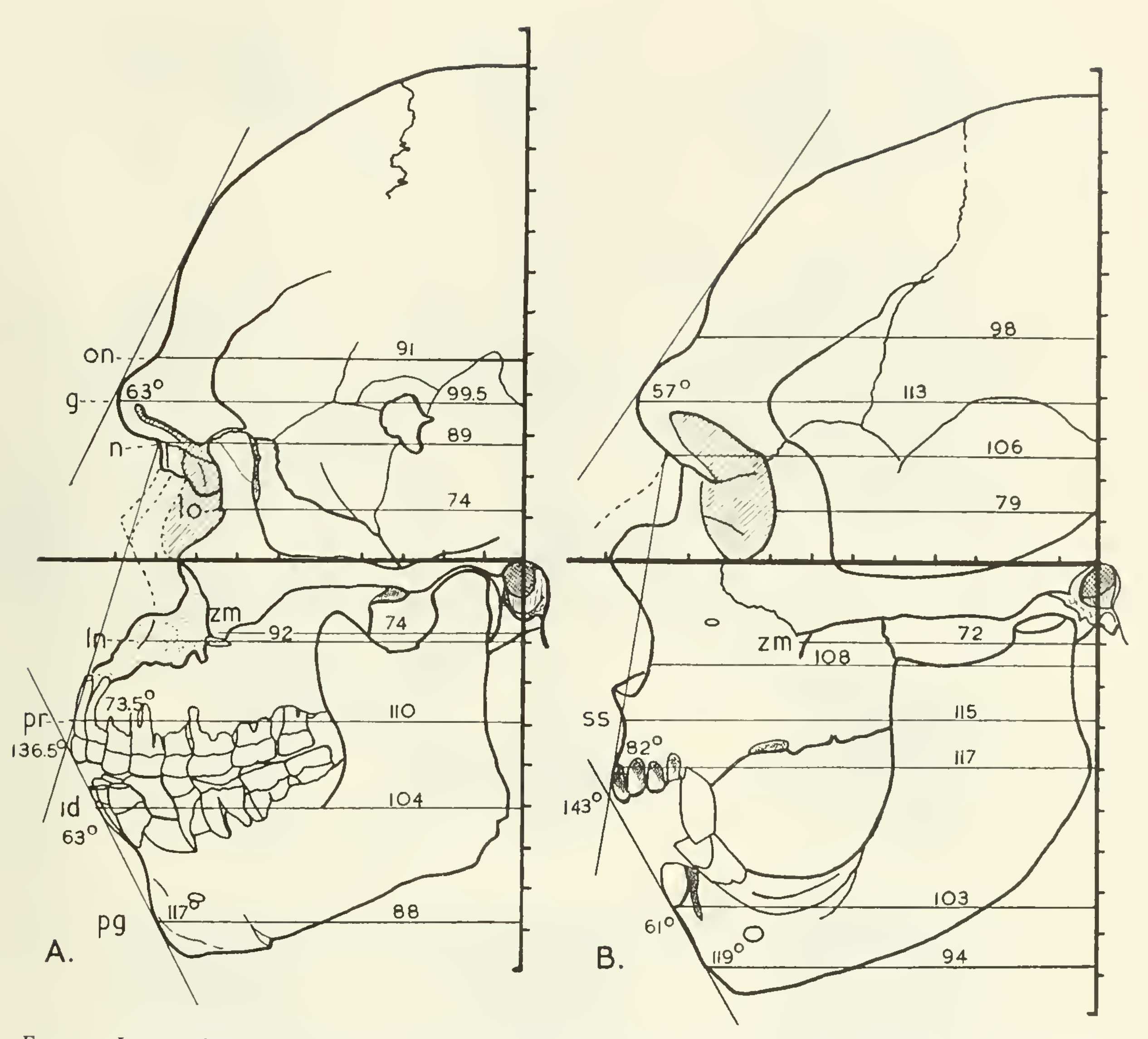


FIG. 172. LATERAL ASPECT, IN OUTLINE, OF THE PRE-AURICULAR HALF OF THE SKULL AND FACE TO SHOW THE PROJECTION OF VARIOUS POINTS IN FRONT OF THE MID-AURICULAR PLANE. A, Skhūl V; B, La Chapelle. *on*, ophryon; *g*, glabella; *n*, nasion; *lo*, lateral orbital point; *zm*, zygo-maxillare; *ln*, lateral nasal point; *pr*, prosthion; *id*, infradental; *pg*, pogonion; *ss*, subspinale. The horizontal lines indicate the length of the projections; the frontal, facial, and chin angles are indicated.

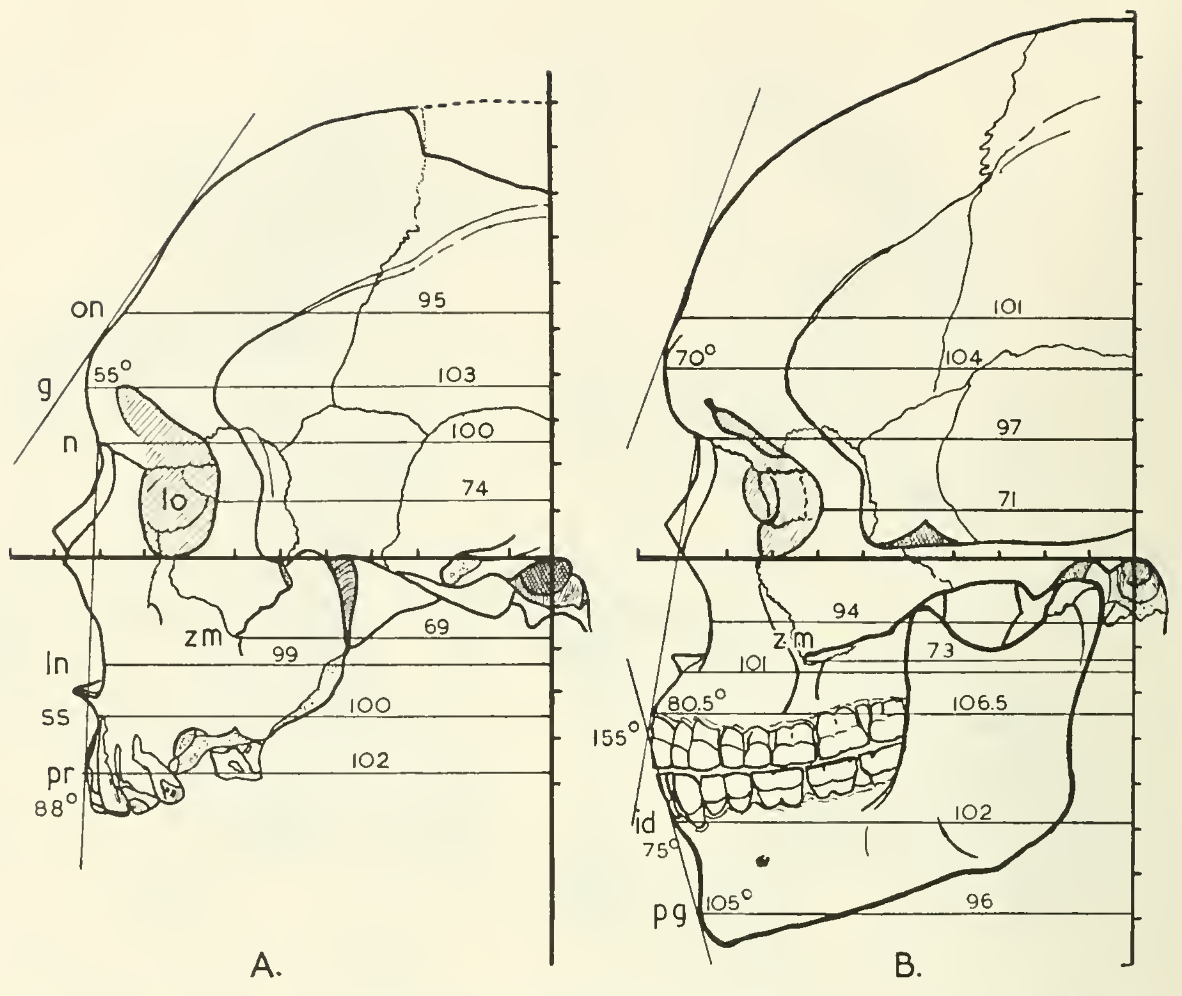


Fig. 173. Lateral Aspect of the Pre-Auricular Half of the Skull and Face. A, Gibraltar; B, Australian (male). Letters have the same significance as in Fig. 172.

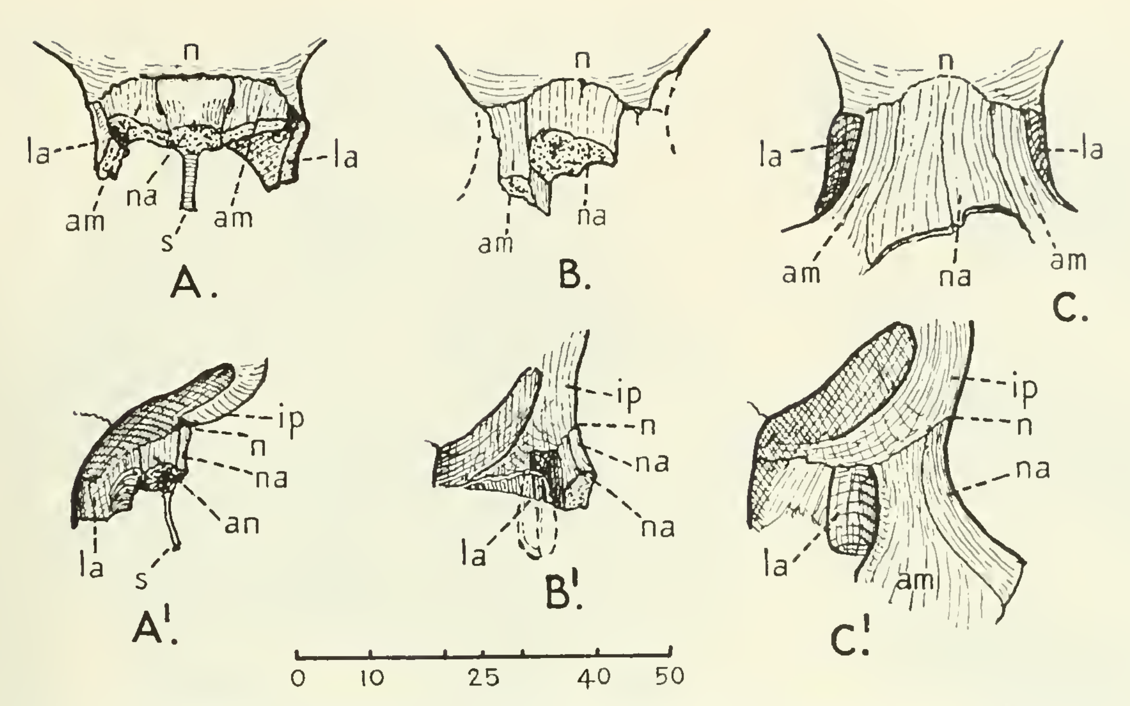


Fig. 174. Anterior and Lateral Aspects of the Inter-Orbital Region and the Root of the Nose. A, A', Skhūl V; B, B', Galilee; C, C', Gibraltar. *n*, nasion; *na*, nasal bones; *la*, lachrimal bone; *am*, ascending process of the maxilla; *s*, septum of the nose; *ip*, inter-orbital process.

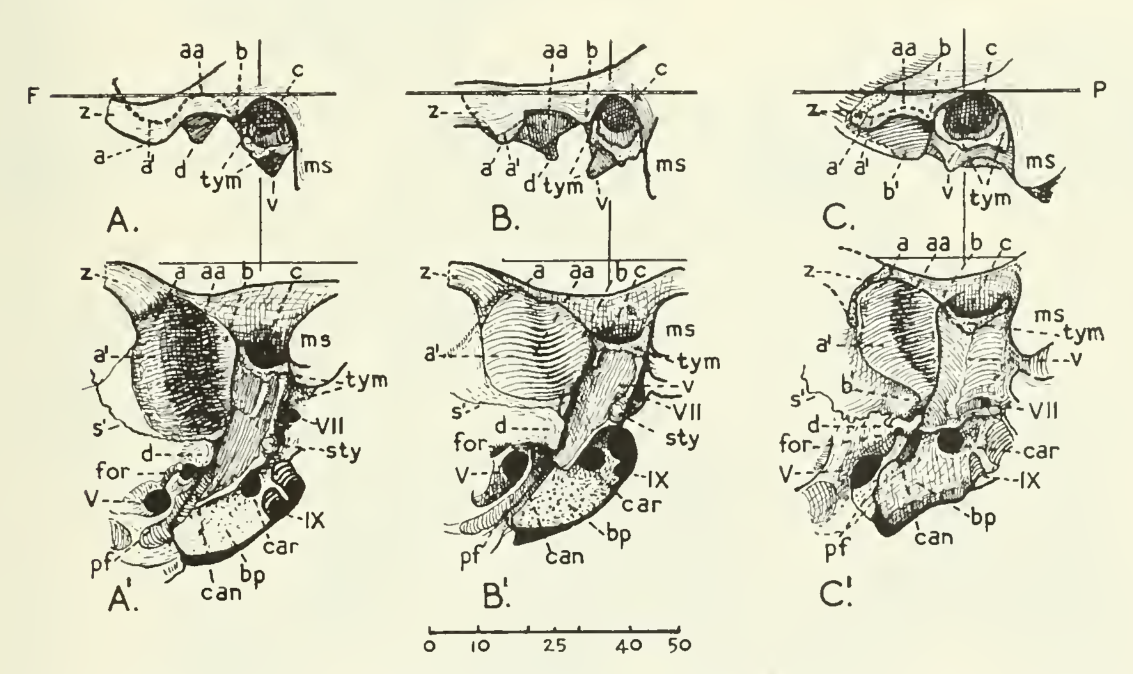


Fig. 175. Lateral and Basal Aspects of the Region of the Temporo-Mandibular Joint. A, A', Skhūl V; B, B', Australian (male); C, C', Gibraltar; *z*, root of zygomatic arch; *a*, articular eminence (lateral aspect); *a'*, deepest median point of articular eminence; *aa*, highest point of cavity; *b*, post-glenoid spine; *b'*, medial glenoid (temporal) spine; *c*, meatus; *tym*, tympanic plate; *ms*, mastoid process; *s'*, spheno-temporal suture; *d*, sphenoid spine; *for*, foramen spinosum; *sty*, styloid process; *v*, vaginal plate (ridge); *car*, carotid foramen; *bp*, basal surface of the petrous; *can*, opening of Eustachian canal; *pf*, post-foraminal process; *V*, *VII*, *IX*, openings for cranial nerves.

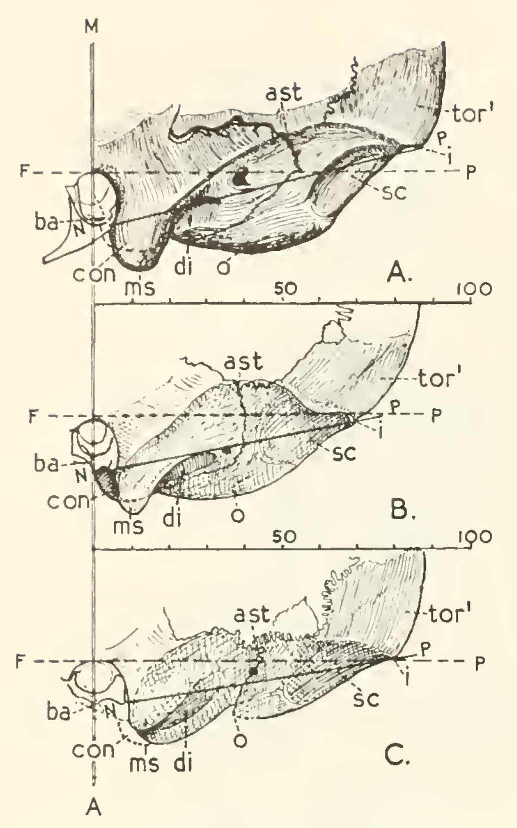


Fig. 176. Lateral Aspect of the Lower Part of the Post-Auricular Region of the Skull. A, Skhūl V; B, Australian (male); C, Gibraltar. *F–P*, Frankfort plane; *N–P*, nuchal plane; *ba*, basion (position); *con*, occipital condyle; *ms*, mastoid process; *di*, digastric groove; *o*, position of opisthion; *ast*, asterion; *sc*, area for attachment of semispinalis capitis; *i*, inion; *tor'*, upper part of torus occipitalis.

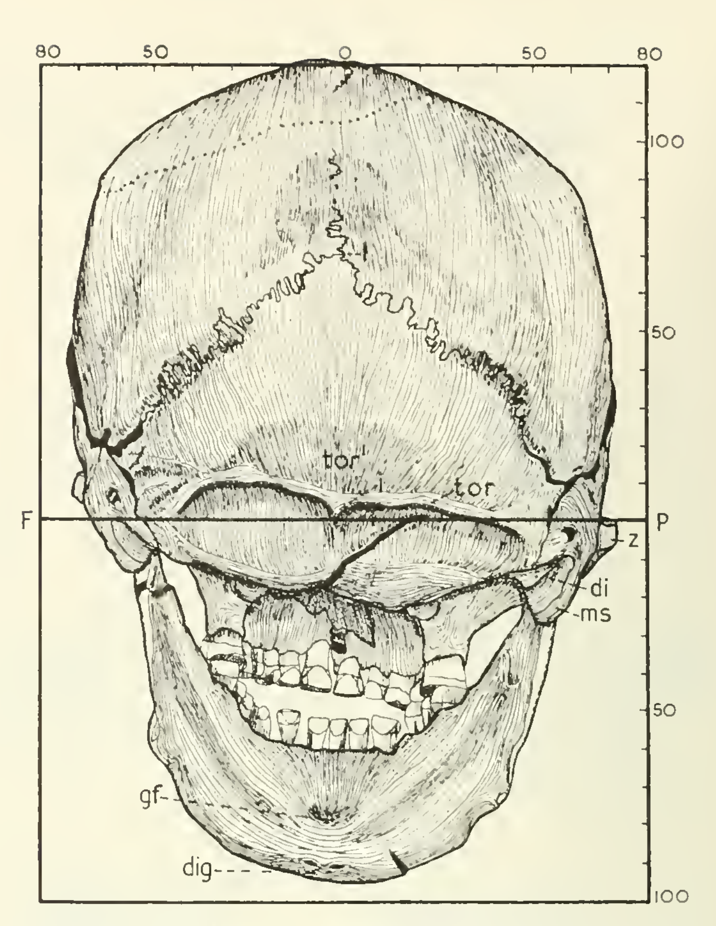


Fig. 177. Skhūl V in Norma Occipitalis. *l*, lambda; *tor'*, occipital extension of torus; *tor*, torus occipitalis; *i*, inion; *z*, zygomatic arch; *di*, digastric fossa; *ms*, mastoid process; *gf*, genial fossa; *dig*, impressions for digastrics.

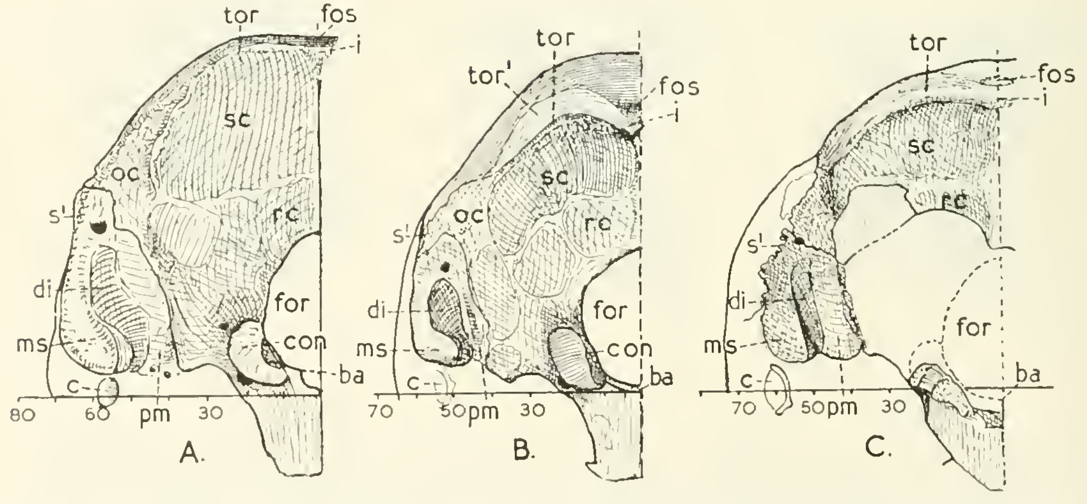


Fig. 178. Basal Aspect of the Nuchal Area of the Skull, Viewed at Right Angles to the Frankfort Plane. A. Skhūl V; B, Australian (male); C, Gibraltar. *fos*, supra-inial fossa; *i*, inion; *tor*, torus occipitalis; *tor'*, occipital extension of torus; *sc*, semispinalis capitis (complexus) muscle (insertion); *rc*, rectus capitis positicus minor (insertion); *oc*, obliquus capitis superior (insertion); *di*, digastric fossa; *ms*, mastoid process; *c*, opening of meatus; *pm*, paramastoid eminence; *for*, foramen magnum; *con*, occipital condyle; *ba*, basion; *s'*, mastoparietal suture.

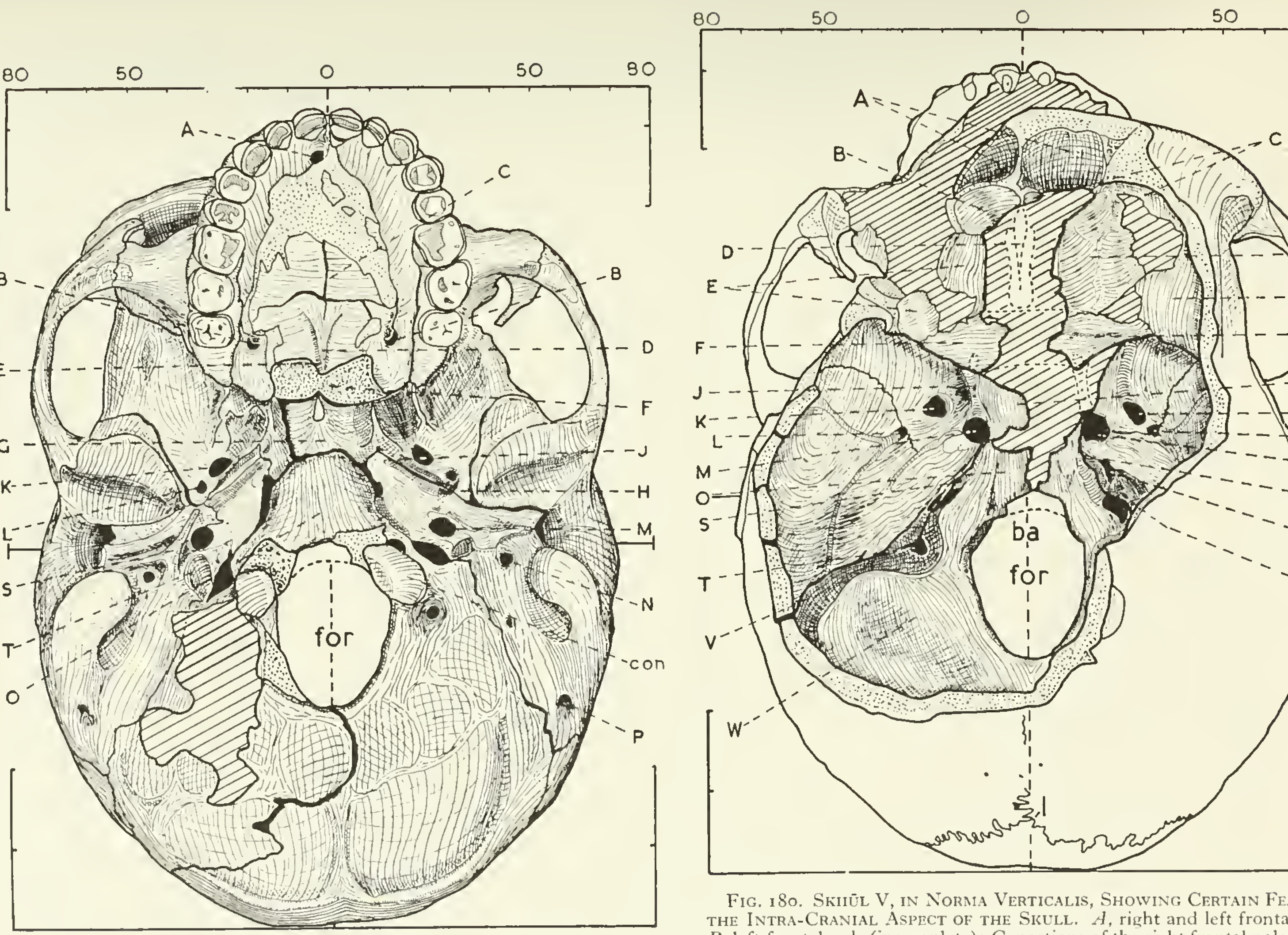


Fig. 179. Skhūl V, in Norma Basalis. *A*, incisive foramen; *B*, greater palatine foramen; *C*, inter-maxillary suture; *D*, palatine crest; *E*, posterior nasal spine; *F*, choanae (filled with breccia); *G*, base of vomer; *H*, sphenoidal spine; *J*, post-foraminal process of sphenoid; *K*, foramen ovale; *L*, foramen spinosum (for meningeal artery); *M*, carotid canal; *N*, stylo-mastoid foramen; *O*, basilar process; *P*, mastoid foramen; *S*, styloid process; *T*, jugular fossa; *con*, occipital condyle; *for*, foramen magnum.

Fig. 180. Skhūl V, in Norma Verticalis, Showing Certain Features of the Intra-Cranial Aspect of the Skull. *A*, right and left frontal sinuses; *B*, left frontal pole (incomplete); *C*, portions of the right frontal pole; *D*, portion of crista galli and ethmoid; *E*, portions of the orbital roofs; *F*, small wing of the sphenoid; *G*, floor for the third frontal convolution; *H*, part of the floor of the pituitary fossa; *J*, groove for the internal carotid; *K*, foramen ovale; *L*, foramen spinosum; *M*, carotid canal; *O*, basilar process; *P*, groove for inferior petrosal sinus; *S*, greater superficial petrosal nerve; *R*, internal meatus; *T*, jugular foramen; *U*, hiatus vestibuli; *V*, lateral sinus; *for*, foramen magnum; *ba*, basion.



CHAPTER XVI

CRANIAL AND FACIAL CHARACTERS OF TABŪN I

(Plate XIX; Figs. 181–93)

THE reader will be familiar now with a problem which has arisen in nearly every chapter: do the people from the Skhūl cave represent one type of humanity and those from the Tabūn cave another? Or are both only variants of the same human stock? This problem arises in the present chapter where we describe the skull of the Tabūn woman (Tabūn I), and compare it with that of Skhūl V. The conclusion we have come to is that we are dealing with two types of humanity: the Skhūl type and the Tabūn type, yet they seem to represent variants of the same stock, *Palaeoanthropus palestinensis*. Of the two types, that of Tabūn stands nearest to the Palaeoanthropic stock or genus of Europe.

The restoration of the skull of the Tabūn woman has involved a great deal of labour, as will be seen from the photographs in Pl. XIX. It had been compressed and crushed into numerous fragments under a great weight of cave earth. The dimensions of the cranium are much smaller than in those of the Skhūl men. The smaller size of the skull of Tabūn I is no doubt partly due to her sex, and having her complete skeleton we are certain of this. The dimensions relating to the length, width, and height of the skull are given in Tables LXXIII–LXXV (pp. 295–6); the glabello-occipital length is 183 mm., its maximum width is 141 mm., the cephalic index being 77, and thus lying in the series intermediate to the 'long' and the 'round' skulls. In this the Tabūn skull corresponds very closely to that of the Gibraltar woman, with which it has many points of resemblance, both in shape and in size (Tables LXXIII–LXXV, pp. 295–6). It will be seen (Fig. 181) that of the total length, 100 mm. (54·6 per cent.) is preauricular, only 45·4 per cent. being post-auricular. Its height from the basion to bregma could not have exceeded 115 mm., being slightly less than in the Gibraltar skull (117 mm.).[1]

The vault of the Tabūn skull rises 105 mm. above the Frankfort plane. The corresponding measurement in the Gibraltar skull is estimated to have been 103 mm. Thus both skulls have remarkably low roofs, 6–8 mm. less than we expect to find in the skull of a modern woman. The height is low in relationship to both length and width. In the Tabūn skull the basi-bregmatic height was not more than 81·5 per cent. of the width and in the Gibraltar cranium the proportion was still less, 80·1 per cent. The height is also low in comparison to the length of the skull, the basi-bregmatic height being 62·8 per cent of the length in the Tabūn skull and 61·5 per cent. in Gibraltar. Thus, the skull of the Tabūn woman is low roofed, but to a degree slightly less than in the Gibraltar woman. This becomes apparent when we consider the difference between the auricular and the bregmatic height. There is only 10 mm. difference in the Tabūn woman, while it is 14 mm. in Gibraltar.

Having surveyed the three chief diameters of the Tabūn cranium we are in a position to make an estimate of its cranial capacity. To employ the formula applicable to modern skulls, certain reductions have to be made on account of the projection of the supra-orbital

[1] Although both basion and bregma are missing in the Gibraltar skull, their exact position can be inferred with some degree of accuracy.

torus. The length of the cranial cavity, measured from the frontal to the occipital pole of the right half, is 161 mm. The glabello-occipital length is 183 mm., therefore brain space makes up 88 per cent. of the total length, bone 12 per cent. The usual proportions in modern skulls are 92 and 8 per cent. We have therefore to reduce the length of the Tabūn skull by 4 per cent., that is, by 7·3 mm., giving a corrected length of 175·7 mm. (ophyro-occipital length, 176 mm.). The maximum width of the Tabūn skull is 141 mm., the width of the cranial cavity at the same point is 130 mm. The brain space is 92·2 per cent. of the width and the bone 7·8 per cent., a proportion quite common in modern skulls. Nor need any reduction be made from the auricular height for along the vault of the Tabūn skull the thickness of the bone varies from 4 to 6 mm., the mean being about 5 mm. Applying Pearson's inter-racial formula for women (Martin, 1928, vol. ii, p. 647):

$$L\ 175{\cdot}7 \times W\ 141 \times AH\ 105 \times 0{\cdot}000375 + 296{\cdot}4 = 1{,}271 \text{ c.c.}$$

The same formula applied to the corrected diameters of the Gibraltar skull gives a cranial capacity of 1,270 c.c. In point of cranial capacity, the Tabūn and Gibraltar women were almost identical.

To the brief account of the diameters of the Tabūn skull just given, certain additional details relating to the thickness of the cranial wall must be added. The thickness of the frontal bone measured from the glabella to the free margin of the internal frontal crest is 19 mm.; of this amount the crest makes up 3 mm. The antero-posterior thickness from the nasion to the site of the foramen caecum is also 19 mm. The frontal bone, above the level of the torus is 5 mm. thick. The occipital bone at the external occipital protuberance has a thickness of 10 mm.; over the right occipital pole the bone measures 6 mm. in thickness.

Schwalbe's method of measuring the height of the vault from the glabello-inial plane gives a base length of 179 mm. and a vault height of 84·5 mm., the height representing 47·2 per cent. of the glabello-inial length. A callotte height index of 45 marks the boundary line between the Neanderthal and modern skulls. The index of the Tabūn skulls thus lies within the lower limit of the Neanthropic series. The Gibraltar skull, on the other hand, falls within the Neanderthal series, its index being 44·6. Skhūl V is emphatically modern in this respect, its index being 52·6. The only Neanderthal skull of European origin with a higher calotte index than that of the Tabūn woman is the Ehringsdorf skull in which the index is 50. Thus we find in the Tabūn woman an early stage in the lifting upwards of the vault of the skull, a Neanthropic feature which finds a full development in Skhūl V.

We turn now to a consideration of the sagittal arch of the skull. The curvature of the bones entering into the formation of the median arch of the calvarium is closely related to the lowness of the vault. The lengths of the arcs, chords, and subtenses of the frontal, parietal, and occipital bones of the Tabūn skull are given in Table LXXVI (p. 296), so that it will be unnecessary to mention them here, save in so far as may be useful for purposes of description.

A sagittal section of the Tabūn frontal is given in Fig. 184 A. It is short, its arc being 107 mm., the chord 96 mm., and the subtense 19 mm. It is short but well curved. The forehead was not receding, the frontal angle being 65°. The outline of the glabellar region is peculiar, being similar to that of the Galilee and Gibraltar frontals, save that the

infra-glabellar region is shorter. There was no sub-glabellar notch as was present in Skhūl V. In Tabūn I the arc from nasion to ophryon is 26·5 mm., its chord 23·5 mm.

A sagittal section of the Galilee frontal is given in Fig. 184 B, and the close resemblance of this to the last is striking. It is true that the arc of the Galilee bone is 18 mm. longer, but it must have been part of a skull with a much higher vault than that of Tabūn I. Its subtense is the same, namely 19 mm., but as the chord is 17 mm. longer than that of the Tabūn skull, the curvature is less. The frontal angle (Table LXXVII, p. 297) is somewhat smaller, being 62·5°. In point of thickness the Tabūn and Galilee frontals are very similar. The two bones are also alike in that the glabellar region projects less forward than the supra-orbital torus on either side (Fig. 184, *g* and *a*). It is otherwise with the Gibraltar frontal (Fig. 184 C) where the glabellar region stands in front of the supra-orbital parts of the torus. Yet, in general conformation, the glabellar region is similar in all three. All have the Neanderthal form of glabellar frontal profile—a form never seen in Neanthropic skulls.

The total length of the median sagittal arc of the Tabūn skull is approximately 333 mm. as against 342 mm. in the thicker Gibraltar skull. The arc of the parietal in the Tabūn skull makes up 35·1 per cent. of the whole, a relatively large amount. The parietal subtense is 20 mm., the chord, from bregma to lambda, 105 mm.

The curvature of the occipital is of particular interest. The vertical compression of the occipital, giving the occiput a 'bun-shape', is one of the diagnostic criteria of the Neanderthal type of Europe. In this respect the occipital bone and all other characters of the Gibraltar skull are typically Neanderthal and we shall therefore proceed to compare the Tabūn occipital with that of the Gibraltar specimen. The median sagittal arc of the Tabūn occipital from lambda to the estimated position of the opisthion measures 108 mm., 60 mm. of this amount being supra-inial. The arc of the Gibraltar occipital measures 106 mm., of which 60 mm. is supra-inial. The arcs are thus not materially different, but in the case of their chords, represented by the diameter from lambda to opisthion, there is a difference. The chord in the Gibraltar skull measures 81·5 mm., representing 76·8 per cent. of the arc. The Tabūn occipital has a chord of 90 mm., a measurement which represents 83·3 per cent. of the arc and indicating a degree of curvature common in Neanthropic skulls. In the Gibraltar skull the subtense of the occipital arc measures 31 mm., equal to 38 per cent. of the chord, while in the Tabūn skull the subtense is less, 29 mm., and represents only 32·2 of the chord. Thus we see that in its curvature and also in the form of the occipital bone the Tabūn woman is Neanthropic, not Neanderthaloid in type. It agrees with Skhūl V in this, although the nuchal plate of the occipital appears to have been rather flatter in the Tabūn than in the Skhūl cranium.

VERTEX

A drawing of the vertex of the Tabūn skull is given in Fig. 187. Those familiar with this aspect of Neanderthal skulls will recognize Neanderthaloid features in the Tabūn outline. Indeed, the outline is very similar to that of the Gibraltar skull. The greatest width is relatively far back, near the junction of the posterior third with the middle third.

A comparison of the transverse diameters brings out no distinctive feature of the Tabūn skull. Usually the forehead is wide in skulls of the Neanderthal type. For example, the minimum frontal width in Gibraltar is 107 mm.; in the Tabūn woman it measures

98 mm.; in the Galilee skull, 97 mm. In this the Palaeoanthropic Palestinians differ from the Palaeoanthropic Europeans. The width in Skhūl V we have seen to be 99 mm. The only European Neanderthal skull which approaches this is the exceptionally narrow adult specimen from La Quina, in which the minimum frontal diameter is 101·2 mm. The minimum frontal width in the Tabūn skull represents 69·5 per cent. of the bi-parietal width, a relationship in agreement with that found in Neanthropic skulls. The maximum frontal width is 121·5 mm., which represents 86 per cent. of the bi-parietal width, a relationship in no way distinctive.

TORUS SUPRA-ORBITALIS

The view obtained of this structure in Fig. 187 leaves the reader in no doubt as to its nature. All the features which the torus represents in Neanderthal skulls are to be seen here. Nevertheless, the width of the torus, measured from one temporal extremity to the other, is less than is found in some Neanthropic skulls. For instance, the toral width in the large male Predmost skull is 116·3 mm., in the Old Man of Cromagnon, 114 mm., in the Tabūn woman it is 113 mm., in the Galilee frontal, 119 mm. We are now convinced that the Galilee frontal, which one of us originally regarded as a female, is that of a male. The greater width and development of the Galilee bone may be ascribed to sex.

The difference between the supra-orbital (upper facial) width and the minimum frontal diameter is an index of the robusticity of the temporal muscle, so closely concerned in mastication. The difference in the Tabūn woman amounts to 15 mm., in the Galilee man, 23 mm. The corresponding figures in La Chapelle is 15 mm., Rhodesian skull, 41 mm., Gibraltar, 11 mm., Neanderthal, 17 mm., Predmost (male), 13·3 mm., Cromagnon (Old Man), 12 mm. Thus the extent to which the supra-orbital width exceeds the minimum frontal seem to be a character of the Palaeoanthropic Palestinians (Table LXXIV, p. 296).

In describing the face we shall have occasion to refer to other characters of the torus supra-orbitalis. Meanwhile, we call attention to the depth (antero-posterior development) of the torus depicted in Fig. 187.

OCCIPITAL VIEW

We expressed the view in the previous chapter that one of the chief differences between Skhūl V and the Neanderthal men of Europe lay in the form of the head. The Neanderthal head appears as if it had been compressed from above downwards, whereas in Skhūl V the skull has the appearance of having been compressed from side to side. The skull of Tabūn I in this respect is intermediate. This is well brought out in Fig. 185, and in Fig. 186 where an occipital view of the Tabūn skull is compared with that of a typical Neanderthal, the Gibraltar woman. Certainly the parietal eminences are almost as much sunken into the parietal contour in the Tabūn skull as in the Gibraltar. Nevertheless, a stage leading on to the Neanthropic form is plainly recognizable in the Tabūn cranium.

Yet in the anatomy of the Tabūn occiput we find distinct resemblances to the Neanderthal type. The occipital bony lines marking the upper limit of attachment of the muscles of the neck form a torus occipitalis. In the Tabūn woman there is a slight indication of an external occipital protuberance on the torus where it crosses the mid-line, but the suprainial pit, so sharply marked in the Gibraltar skull, is ill defined in the Tabūn specimen. The torus is larger and stronger in the Gibraltar skull.

Another point of difference between the Gibraltar and the Tabūn skulls is seen in the position of the mastoid region of the temporal bone. In the Gibraltar skull, as in that of the anthropoid, the mastoid is directed inwards as well as downwards (Fig. 186 A, *ms*), whereas in the Tabūn skull the modern or almost vertical position has been assumed (Fig. 186 B). In both skulls the mastoid process is small and the digastric fossa is exposed on the lateral aspect of the skull. This fossa is peculiarly extensive in the Tabūn skull (Fig. 186 B, *di*). The paramastoid ridge in both descends far below the apex of the mastoid, as in the anthropoid. This ridge, which is made up of mastoid and occipital elements separated by the masto-occipital suture, forms the medial border of the digastric fossa (Fig. 186, *di*). Thus, although the occipital aspects of the Tabūn and Gibraltar skulls differ in their outline, in a multitude of anatomical details they agree. In the Tabūn occiput we see an early stage in the differentiation of the Neanthropic type, in Skhūl V a more advanced stage.

The bi-asterionic and other breadth measurements of the occipital region are given in Tables LXXIV and LXXXII (pp. 296, 298).

SQUAMA TEMPORALIS

There are certain features of the lateral aspect of the Tabūn skull which are best considered here. One of these concerns the squama of the temporal bone. In Neanderthalians the squamous border of this bone is usually slightly curved and does not rise high above the Frankfort plane. This border in the Gibraltar skull ascends 33 mm. above the Frankfort plane. Its length, measured from the squamo-mastoid angle (entomion) to the most distant point on the spheno-temporal suture, is 57·5 mm. The height is 57·3 per cent. of the length. The corresponding measurements of the Tabūn skull are: length, 60·5 mm.; height, 37 mm.; height ratio, 60·9 per cent. If we take a modern skull of approximately the same length as the Tabūn specimen (a Bushman's) we find a length of 64·5 mm., a height of 40·5 mm., and a ratio of 62·8 per cent. It will be noted that in passing from the Neanderthal type to the modern there is an increase of the squama both in length and in height, but the increase is relatively greater in the height. In the Tabūn skull we find a stage which is intermediate to the Neanderthal and the modern types.

TEMPORAL MUSCULATURE

The temporal muscle is developed to a moderate degree. If we measure its development as described on p. 245, we find that the segment of the arc from the Frankfort plane to the lower temporal line is 80 mm. The total arc to the mid-sagittal plane of the skull measures 145 mm. The corresponding measurements in the Gibraltar skull are 75 mm. and 135 mm., while in a Bushman they are 65 mm. and 143 mm. Relatively the areas of attachment in the two ancient skulls were similar but in the bulk of muscle (p. 256) the Tabūn woman exceeded the Neanderthal one.

SPHENOID REGION

Many of the characters of this region have already been discussed in describing Skhūl V (p. 239). The sphenoid region in the Tabūn skull is badly broken, but sufficient is preserved to assure us that the characters are those found in the Gibraltar and other Neanderthal skulls of Europe. The alisphenoid is preserved in its entire width on the right side

and other parts are present on the left. In Fig. 181, a reconstruction based upon the intact parts of both sides of the skull, we have indicated the original articulations in the region of the pterion. The great wing, just above the infra-temporal crest, is 26 mm. wide, 3 mm. more than in the Gibraltar skull, 4·5 mm. more than in the Galilee sphenoid, and 2·5 mm. more than in Krapina C.[1]

The most anterior point of the spheno-temporal suture in the Gibraltar skull lies 41 mm. behind the lateral margin of the orbit. The distance in the Galilee skull is 43 mm. Although both malars are missing in the Tabūn skull, we can infer with some accuracy the position of the lateral margin of the orbit; the orbito-sphenoid length was approximately 43 mm. This measurement in the robust skull of a male Australian is 26 mm. and in a male Bushman 26·5 mm. In the evolution of the Neanthropic type of skull the squama of the temporal has expanded forwards and compressed the great wing of the sphenoid. The Tabūn skull, like the Galilee and Skhūl V specimens, possesses definite Neanderthal traits in the sphenoid region of the temporal fossa.

As the orbital plate of the malar enters into the formation of the temporal fossa we may consider here its extent. We have no part of a Tabūn malar but we have two of its chief sutural borders, the fronto-malar and the malo-sphenoid. A cast of the Galilee malar fits the gap very well and the Tabūn malar was undoubtedly similar to the Galilee bone and to others from Neanderthal skulls. Measured by calipers, the distance in the Gibraltar skull from the mid-point of the orbital margin to the nearest point of the malo-sphenoid suture is 18 mm.; in the Galilee skull it is 20 mm.; in Tabūn (estimated), 16 mm. The corresponding measurement in a male Australian is 13·5 mm. and in a Bushman skull 14 mm. A wide orbital plate is a Neanderthal character.

BASE OF THE CRANIUM

An exact tracing of the basal aspect of the Tabūn cranium is reproduced in Fig. 188, where it is viewed at right-angles to the Frankfort plane. It will be seen at once that a large part of the base, including the basilar process of the occipital and the left half of the foramen magnum, has been detached and pushed forwards towards the left side of the cranium. Fortunately the region of the ear, the mastoid, and the greater part of the occipital bone have retained their original positions, so that it is possible to attempt a descriptive and pictorial restoration which is of value. Actual restoration of the specimen was found to be impossible. With the forward movement of the basilar process the apex of the left petrous was detached and crushed, and all the displaced parts have become so shattered and firmly adherent that restoration has not been attempted.

The basilar process of the occipital is complete; the basion is present. In front there is an eminence with which the vomer had articulated. The length from basion to vomerine attachment measures 26·5 mm. The basion and adjacent part of the basilar plate are missing in the Gibraltar skull, but we estimate the original length to have been about 25 mm. The basilar process of the Tabūn woman, however, is quite unlike the Gibraltar process in its conformation. The Tabūn basi-occipital is convex from side to side on its lower surface, as in Neanthropic skulls, and in front of each occipital condyle there is a wide shallow fossa for the attachment of the great rectus capitis muscles. The Gibraltar

[1] For a full description and discussion of the Galilee sphenoid see Keith, 1927.

basilar process is flat from side to side on its lower surface and the precondylar fossae are absent.

Another remarkable feature of the Tabūn basilar process is its thinness at its anterior end. From the floor of the pituitary fossa to the point where the hinder end of the vomer was attached measures only 9 mm. The corresponding diameter in the Gibraltar skull is 13 mm., and in modern skulls this varies between 15 and 20 mm. As in Skhūl V, the dorsum sellae is represented by a low ridge, the fossa being shallow. Although the basilar process may have been compressed in a dorso-ventral direction at its anterior end, we do not think this thinness is a result of post-mortem compression.

FORAMEN MAGNUM

The anterior border and the left marginal area of the foramen magnum has been moved forwards and thrust away from the mid-line about 17 mm. (Fig. 188). The dimensions, however, and the plane in which the foramen was set may be estimated. The length we believe to have been 36 mm., with a width of 28 mm., dimensions somewhat less than in Skhūl V (Table LXXVII, p. 297). The foramen magnum of the Bushman with which we compared it was 42 mm. long and 34 mm. wide, exceptional dimensions. In Fig. 181 it will be seen that we have placed the basion at the same level as the opisthion, the plane of the foramen magnum being parallel to the Frankfort plane. This is a primitive feature. The plane was directed downwards and forwards in Skhūl V, as it is in modern skulls, making an angle of 11·5° with the Frankfort plane.

Other regions of the base of the skull we shall describe in connexion with the temporo-mandibular joint, the auricular region, the area of fixation, and with the face. One point, however, demands mention now. It will be seen from Fig. 188, *pt*, that the base of the pterygoid process of the sphenoid is preserved on the left side. It is inflated by an air-sinus, which we infer to be an extension of the sphenoidal sinus. This extension was present in the Galilee pterygoid and is a primitive or anthropoid feature. The extension of the sinus was apparently absent in Skhūl V, as in most modern crania.

FACE OF TABŪN I

The basi-cranial axis (basi-nasal length) was remarkably short in Skhūl V (100 mm.). Its length in the Tabūn woman as depicted in Fig. 181 is 108 mm.; in the Gibraltar woman it is 106 mm. Thus, in the length of basi-cranial axis the Tabūn woman reaches the highest mean for modern races (Eskimo, 108 mm.). The basi-alveolar length, which was so great in Skhūl V (115 mm.), is less than the basi-nasal length in Tabūn I. It measures 102 mm. In the Gibraltar skull it is 108 mm. The upper face length in the Tabūn skull is 79 mm., almost the same as in the Gibraltar skull (78·5 mm.). Both have long faces as is usual in Neanderthal people. The facial angle (Table LXXVII, p. 297) is 92°; that is to say, the face of this woman, so far as the angle is concerned, is ultra-modern, reaching the highest group of orthognaths. It resembles the Gibraltar skull in this feature, the facial angle in the latter being 88°, which gives it a place in the ortho-gnathous class. In the chief dimensions of the face there is agreement between the Tabūn and the Gibraltar skulls.

In spite of the fact that the upper face of the Tabūn woman is orthognathous, in life she must have had a prognathous appearance. This is due to the rapid falling away of the

chin. The angle which the chin forms with the Frankfort plane (Fig. 181) is only 48°, an anthropoid amount. The total angle of the muzzle (upper facial and chin angles) is 140°. In the prognathous Skhūl V the muzzle angle was about the same, namely, 136·5°.

In both the Tabūn and Gibraltar skulls the face as it descends is bent backwards so as to lie under the base of the skull instead of projecting forwards, as in high degrees of prognathism. This is evident when we measure the angle which the face, represented by the nasi-alveolar line, forms with the cranio-facial axis, represented by the basi-nasal line. This angle measures only 66° in the Tabūn skull, 69° in the Gibraltar cranium, and 82° in Skhūl V. Prof. Sera (1909) observed that the base of the Gibraltar skull was remarkably straight, as in anthropoids; we suspect that this was also the case in the Tabūn skull.

CHIEF DIMENSIONS OF THE FACE

The face of the Tabūn skull is represented from the side in Figs. 181, 190, and from the front in Fig. 189. The parts of the face which are missing can be learnt from the latter and also from Pl. XIX. The malars are missing on both sides and the ascending process of the maxilla, which makes up so large a part of the lateral wall of the nose and of the floor of the orbit, is present only on the right side. The presence of the latter, however, has given us the means of determining the height of the face and the width of the nose. These dimensions are given in Tables LXXVIII–LXXX (pp. 297–8).

The height of the upper face, as we have just seen, is 79 mm. The total facial height is 118 mm., a face of moderate height on our European standard. The nasal segment of the face measures 58 mm., and the upper alveolar 21 mm. The masticatory part of the face, from the naso-spinale to the gnathion, measures 66 mm. These amounts and proportions are in no wise remarkable.

The torus supra-orbitalis (p. 256) formed a very characteristic feature of the Tabūn face. In its conformation the Tabūn torus is Neanderthal in type. The torus of the Galilee skull is 6 mm. wider, 1 mm. thicker (dorso-ventral diameter), and projects forwards about 3 mm. more than in the Tabūn skull.

What was the bizygomatic width of the Tabūn face? We have seen that the basal part of the skull has been carried outwards and downwards from the mid-line to an extent of about 17 mm. (Fig. 188). The forward part of the temporal squama with the root of the zygoma and portions of the great wing of the sphenoid have been deflected transversely and laterally by an amount not more than 15 mm. The root of the left zygoma projects 80 mm. from the mid-line (Fig. 189), and if we make allowance for the deformity by deducting 15 mm. the result is a bizygomatic width for the left half of the Tabūn face of 65 mm., giving a facial breadth of 130 mm. The conformation of the extant parts of the face favours this relatively narrow face. The width is a little less than in the Gibraltar face (Table LXXVIII, p. 297) and relatively much less than in Skhūl V, in whom the facial breadth exceeds the maximum width of the skull. The bizygomatic width in the Gibraltar skull is about 134 mm., the width of torus 118 mm.; its thickness 15 mm. The Gibraltar woman was more robust in bone substance than her Palestinian cousin.

NASAL PARTS OF THE FACE

When the Galilee frontal was first discovered one of us was much impressed by the mass of solid bone which went to form the root of the nose and the parts below the

glabella, which are within the interorbital process of the frontal. Although the Tabūn nasals have become detached from the frontal and lost, leaving only their areas of contact, there can be no doubt from the extent and roughness of these areas that the structures at the root of the nose in the Tabūn cranium had the same robust form as in the Galilee man. A view of the areas for attachment of the nasal and other bones to the interorbital process of the Tabūn frontal is shown in Fig. 189 and also in Pl. XIX B. A semi-diagrammatic view of the areas of attachment is shown in Fig. 191. The area for the attachment of the right nasal bone was 9 mm. wide; from nasion to roof of the nasal cavity 12 mm. In the middle line of the area, from nasion to nasal septum, there is a raised median area. This becomes continuous with the frontal processes which articulate with the septum of the nose (Fig. 191, *s*).

The areas for the attachment of the maxilla and the lachrymal are also shown in Fig. 191, with the opening of the frontal air sinus and a small area of the roof of the nasal cavity. Fortunately the ascending process of the maxilla is intact and still possesses its area for articulation with the frontal.

The width of the interorbital process (and root of the nose) measured between the articulation of the lachrymal bones (lachrymale) is 32 mm., a wide root. The same measurement in the Gibraltar skull is only 26 mm. Indeed, a comparison of the two drawings in Fig. 191 will allow the reader to form an idea of how massive the root of the nose was. In the Galilee skull the bi-lachrymal width is 28 mm. The width (inner bi-orbital) between the inner ends of the fronto-malar suture in the Tabūn skull is 102 mm., the interorbital process of the frontal representing 31·3 per cent. of this measurement. In the Gibraltar skull the total width is 106 mm., the interorbital element forming 24·5 per cent. of the whole. The corresponding measurement in the Galilee frontal is 110 mm. and the ratio 25·4.

Two areas with which the right nasal bone articulated have been preserved—the frontal for its base and the maxillary for its lateral margin (Fig. 189). At its base and at the bridge of the nose the two nasal bones had together a width of 20 mm.; in the Gibraltar nose the width at the base is 13 mm. and at the bridge 14·5 mm. The Tabūn nose must have been arched transversely quite as much as the large Gibraltar nose (Fig. 191).

The nasal border of the ascending process of the maxilla, as will be seen from Fig. 181, is strongly concave and not very long (25 mm. measured with calipers). The same measurement in the Gibraltar skull is 26 mm., and although the lateral nasal border is concave, the concavity is not so marked as in the Tabūn skull. We infer that the nasal bones of the Tabūn woman had the characteristic shape seen in the Gibraltar nose (Fig. 174 C′), but was more concave, as shown in Fig. 190.

At their lower ends the width of the transverse arch formed by the nasal bones was 30 mm. wide; in the Gibraltar skull the diameter is 21 mm. No such development of nasal bones has been met with in any human skull before.

In one respect, however, the nasal part of the Tabūn face differed from the Gibraltar countenance. In the latter skull the ascending process of the maxilla has a rounded convex form and is very wide, measuring 21·5 mm. between the inner margins of the lachrymal fossae and the lower end of the naso-maxillary suture. This measurement in the Tabūn skull is 18 mm., and in shape and convexity of the ascending process of the maxilla resembles that of Neanthropic skulls.

The height of the nasal cavity, as already mentioned, is 58 mm., nearly the same as in the Gibraltar skull. The width is also great, namely, 34 mm., only 0·5 mm. less than in the exceptionally wide nose of Gibraltar. The width of the Tabūn nose is 58·6 per cent. of the height, thus falling into the exceptional hyperchamaerrhine class.

We found, when describing the nasal region of Skhūl V, that in most points the resemblances were to a Neanthropic form of nose, but in Tabūn I the affinities are plainly with the Neanderthal type, as represented by the Gibraltar cranium. There is a peculiar feature in the lateral margin of the nasal aperture in the Tabūn skull which links it to the Gibraltar specimen. The lateral margin in Tabūn I is a single round ridge in its lower half, but in its upper half it divides so as to form two borders, a medial which is sharp and forms the true margin of the aperture, and a lateral which ascends on the outer surface of the ascending process of the maxilla to end in the naso-maxillary suture. The maximum distance between these margins is 3 mm. Although not so plainly seen, the same conformation is present in the Gibraltar skull. We believe that this double margin has not been noted before. It is probable that the lateral ridge represents the original margin and that the medial has been produced in the evolution of the human nose.

As regards the lower margin or sill of the nasal opening, the Tabūn and the Gibraltar skulls differ. The nasal sill in the Gibraltar nose is a sharp, single, raised ridge uniting the lateral margin with the nasal spine. Within the outer ridge is an inner ridge separated from the former by a narrow fossa, the paraseptal fossa.[1] In the Tabūn nose these ridges are represented by mere lines with a shallow fossa between them (Fig. 189). There was a high septal ridge in the premaxillary part of the nasal floor but apparently this ridge did not project forwards to form a nasal spine.

THE ORBITS

There are but two borders of the right Tabūn orbit, the upper formed by the supraorbital torus, and the medial by the ascending process of the maxilla. The malar is missing on both sides, but the gap can be filled by the malar of the Galilee skull, save that the Tabūn orbit was clearly not so high as in the Galilee specimen. The height of the orbit we estimate to have been 33 mm., while the width from the fronto-maxillary point to the lateral margin was *c.* 42 mm. The same measurements for the Gibraltar orbit are 39 mm. and 44 mm. and for Galilee 37 mm. and 40 mm. For a Neanderthal type the Tabūn woman had a remarkably shallow orbit, in this bearing a resemblance to Skhūl V.

PROFILE

An outline of the profile of the face of the Tabūn woman is given in Fig. 190 A. The drawing is based upon the parts preserved on both sides, but the ear of the left side of the skull gives the position of the mid-auricular plane. For comparison we give a similar drawing made from the skull of the Gibraltar woman (Fig. 190 B). The comparison shows a surprising number of resemblances. The outline of the Tabūn mandible has been fitted to the Gibraltar skull and it will be seen that the fit is good. There was, no doubt, despite the orthognathism of the Gibraltar cranium, the same retreating chin as in the Tabūn woman, giving the same projecting muzzle with a 'muzzle angle' of about the same size as in her, namely, 140°.

[1] These structures are now visible, the matrix having been removed from the interior of the nasal cavity.

A comparison of the projected measurements of the faces of the Tabūn and the Gibraltar skulls are very similar and are given in Table LXXIX (p. 297). In both the projection of the glabellar point is almost the same and in the outline of the glabellar region there is agreement, whereas both differ in this respect from Skhūl V (Fig. 172 A). The nasion, however, is only 5 mm. below the glabella and 1 mm. behind it in the Tabūn woman; in the Gibraltar skull these distances are 11 mm. and 3 mm. respectively. In Skhūl V there is a deep notch at the nasion, that point being 10·5 mm. behind the glabella and 10 mm. below it.

The Tabūn woman in the lack of flatness of the upper face also agrees with Gibraltar and differs from Skhūl V. This is best measured by the distance which the lateral margin of the orbit lies behind the nasion (Fig. 190, *lo* and *n*). This distance is 26 mm. in the Gibraltar skull, 21·5 mm. in the Tabūn reconstruction and 15 mm. in Skhūl V.

Below the Frankfort plane all the projections in the Gibraltar face exceed those in the Tabūn skull, particularly those of the nasal process of the ascending maxilla and of the lateral wall of the nose (lateral nasal point, Fig. 191, *ln*). We may say, however, that in spite of these differences, the characters of the face link the Tabūn woman more closely to the Neanderthal than to the Skhūl type.

TEMPORO-MANDIBULAR JOINT AND RELATED PARTS

Two diagrams of the temporo-mandibular joint and of the neighbouring portions of the skull of the Tabūn woman are given in Fig. 192 (see also Pl. XVIII). In (A) the joint is shown in profile and represents the relationship of the parts to the Frankfort plane. The highest point of the articular cavity reaches the level of the Frankfort plane. The articular surface at the mid-point of the eminence descends 5 mm. below the plane; at its lateral part, 6 mm. The cavity, which is extensive (length, 22 mm.; width, 23 mm., Table LXXXI, p. 298), is concave from side to side and also concave from front to back, for the articular surface continues to rise almost until the anterior border is reached. The cavity is more extensive and deeper than in the Gibraltar skull, approaching the form met with in Neanthropic skulls. But as in the Gibraltar skull, the medial border of the articular surface, which reaches the spheno-temporal suture, descends far below the Frankfort plane, namely 10·5 mm. in Tabūn and 13 mm. in Gibraltar. A tuberosity is formed by the sphenoid on the medial side of the joint (Fig. 192, *d*); this is almost absent in the Gibraltar skull.

TYMPANIC PLATE

The reader will obtain a better conception of the tympanic plate of Tabūn I from Fig. 192 than from a lengthy verbal description (also Pl. XVIII D). The plate may be described as intermediate to the oblique form seen in Neanthropic skulls and the horizontal form seen in Neanderthal skulls such as Gibraltar. Its outer or auricular border is divided by a notch into two parts, the posterior applied to the mastoid process; it has a wide rough border. The anterior part, chiefly vertical in position, has a rough but bevelled margin. It is the anterior, not the posterior as in Sinanthropus, which becomes attached to the vaginal process. This process has a wide (4 mm.) rugose margin, not sharp and straight as in Neanthropic and also in Neanderthal crania. The length of the vaginal process, from the auricular border to where it abuts on the carotid canal, is 15 mm.

(21·5 mm. in Gibraltar; 16·5 mm. in a Bushman), and its height from the petro-temporal (Glaserian) fissure to the free edge is 11 mm., as against 15 mm. in a Bushman and 9 mm. in Gibraltar, the latter being also more oblique in position.

AUDITORY MEATUS

The greater axis of the meatus is directed backwards and upwards, measuring 11 mm. in length, while the vertical axis measures 8 mm. It has to be noted, however, that it is from the anterior moiety that the meatus issues, the posterior part being in the nature of a recess (Fig. 192 A). The meatus, like the tympanic plate, is intermediate in its characters between the Neanderthal and the modern form.

As in the Gibraltar skull, the tympanic plate has a horizontal area behind the vaginal ridge; at the posterior margin of this area, nearly 10 mm. in width, there is a depression in which opens the canal for the facial nerve. There was, apparently, no styloid process ossified to the temporal, but an embrasure in the vaginal plate marks the site of attachment.

In brief, and considering the balance of the evidence, the characters of the tympanic plate tend to associate the Tabūn woman with the Neanderthal type, while the same characters of Skhūl V tend to associate that individual with the Neanthropic type.

NUCHAL AREA

The nuchal area, as is to be expected, is smaller in the Tabūn woman than it is in the Skhūl man (p. 247). Yet for a woman the neck was strong and thick. In Fig. 193 a comparison is made between the areas of fixation in the Tabūn and the Gibraltar skulls, as viewed in profile. The actual dimensions are given in Table LXXXII (p. 298). We may say here, however, that the length of the nuchal plane is 71 mm. in Tabūn, 72 mm. in Gibraltar, being practically the same. The bi-mastoid (nuchal) width, however, is much greater in the Tabūn skull, being 136 mm. against 128 mm. in the Gibraltar cranium.

One difference in Fig. 193 is immediately noted. In the Gibraltar skull the inion is on the Frankfort plane, but in the Tabūn woman it is 13 mm. above the plane. This is an interesting if rather an individual feature. We have seen how orthognathous is the Tabūn woman, her face, as it were, being bent backwards so as to underlie the skull to a greater degree than in prognathous individuals. Compensation is obtained by giving the individual a greater power of keeping the head in an extended position, the developmental movement taking place at the occipito-atlantal articulation. When the Tabūn woman had the inion and the nuchal area in the plane usual in most skulls, then her face was turned forwards and upwards, compensating for its hyper-orthognathy.

There is a close similarity of the nuchal area of the Tabūn woman to that of the Gibraltar female, both manifesting typical Neanderthal characters. We have already described the occipital torus and the occipital lines in the Tabūn skull (p. 256); they are, as just stated, Neanderthal in character and yet exhibit a tendency towards the Neanthropic type.

Dimensions of the mastoid and of the paramastoid processes are given in Table LXXXII (p. 298). The apex of the mastoid descends 17·5 mm. below the Frankfort plane in the Tabūn skull; 18·5 mm. in Gibraltar. It is of small size in both, but is placed

more vertically in the Tabūn skull than in the Gibraltar skull (Fig. 187). Both skulls have greatly developed paramastoid processes (Fig. 193, *pm*) which are certainly Neanderthal features, and in both the smallness of the mastoid process leads to an exposure of the digastric fossa. It is more exposed in the Tabūn than in the Gibraltar skull.

The nuchal plane forms an angle of 17·5° with the Frankfort plane in the Tabūn skull (Fig. 193) and 9° in the Gibraltar skull. It will be noted that the nuchal area of the Tabūn skull has a greater convexity below the nuchal plane than is the case in the Gibraltar skull. Extreme flatness of the nuchal area is a Neanderthal character.

SUMMARY

We have made a survey in this chapter of the characters exhibited by the skull of the Tabūn woman. We kept in mind three questions which we hoped to answer:

(1) What is her relationship, so far as her cranial characters are concerned, with the male Skhūl skull described previously? Cranial characters support the view, already founded on a comparison of their skeletons, that they represent different types or breeds of humanity, and yet breeds of the same stock. In the Skhūl cranium there are many Palaeoanthropic features, but these are overshadowed by those of a Neanthropic character. In the Tabūn cranium it is the opposite—the Palaeoanthropic features vastly preponderate over the Neanthropic.

(2) What is her relationship to known types of fossil man? We have found that the cranium of the Tabūn woman in capacity, in dimensions, and in anatomical characters has many points in common with the Neanderthal type of Europe, as represented by the Gibraltar woman. The chief differences lie in the manifestation of Neanthropic characters by the Tabūn woman, particularly in the direction in which her brain has expanded, leading to a raising of the vault of the skull and a flattening of the sides. There is not the cranio-caudal compression of the occiput nor the extreme flattening of the nuchal plate of the occipital which characterizes the Neanderthal skull. In the temporo-mandibular region we also find Neanthropic features. We are of the opinion that the Tabūn woman represents a separate race of the Neanderthal type, the difference between the Tabūn and Gibraltar skulls being of approximately the same amount as that which distinguished the skull of a European from that of a Negro.

(3) What is her relationship to the Galilee skull? We believe that they belong to the same race, the differences, so far as they are revealed from the frontal bone, malar and sphenoid, being due to sex and not to race.



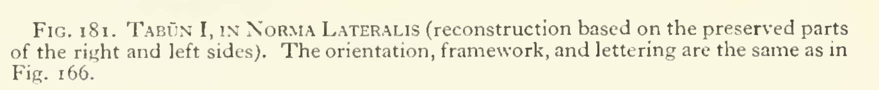


Fig. 181. Tabūn I, in Norma Lateralis (reconstruction based on the preserved parts of the right and left sides). The orientation, framework, and lettering are the same as in Fig. 166.

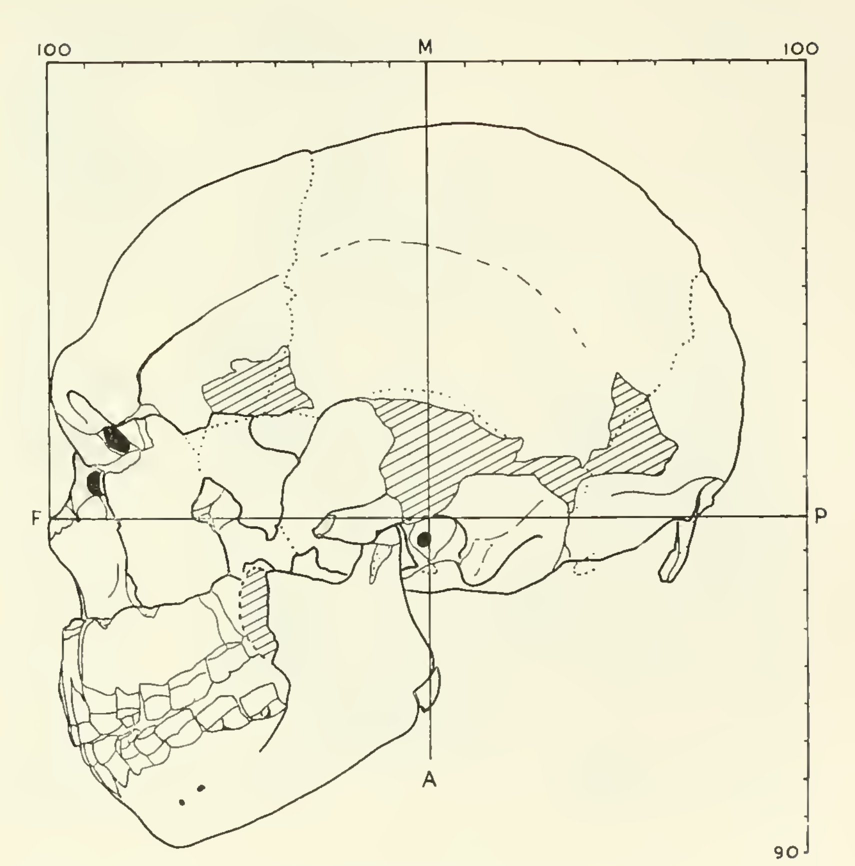


Fig. 182. Tabūn I, in Norma Lateralis. Outline tracing of the left side. Defective or restored areas are shaded obliquely.

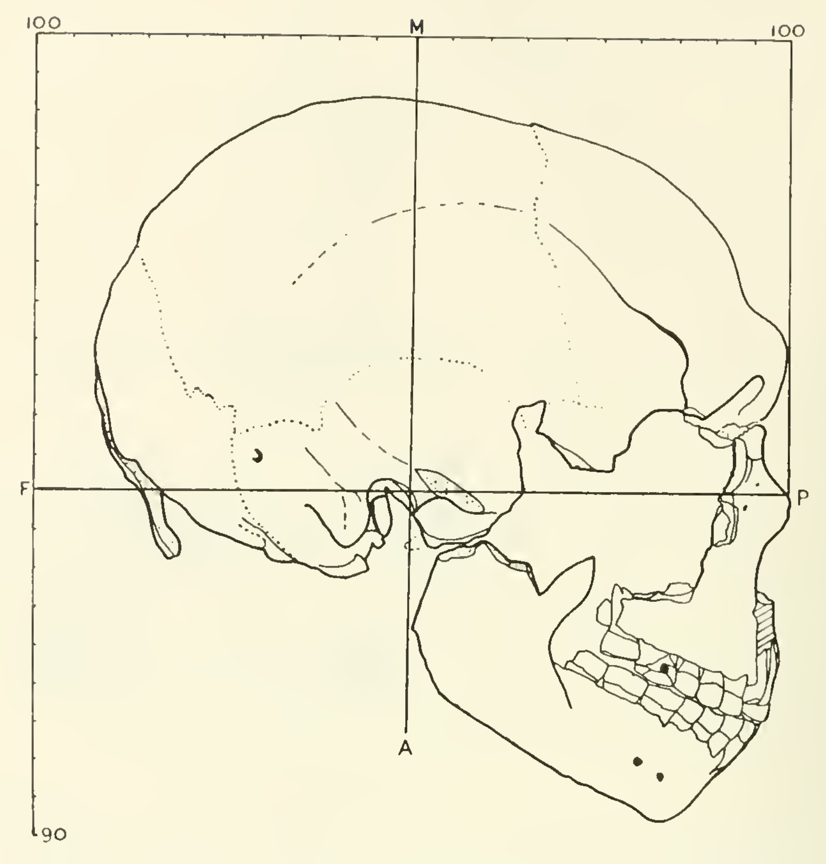


Fig. 183. Tabūn I, in Norma Lateralis. Outline tracing of the right side. The course of the sutures is indicated.

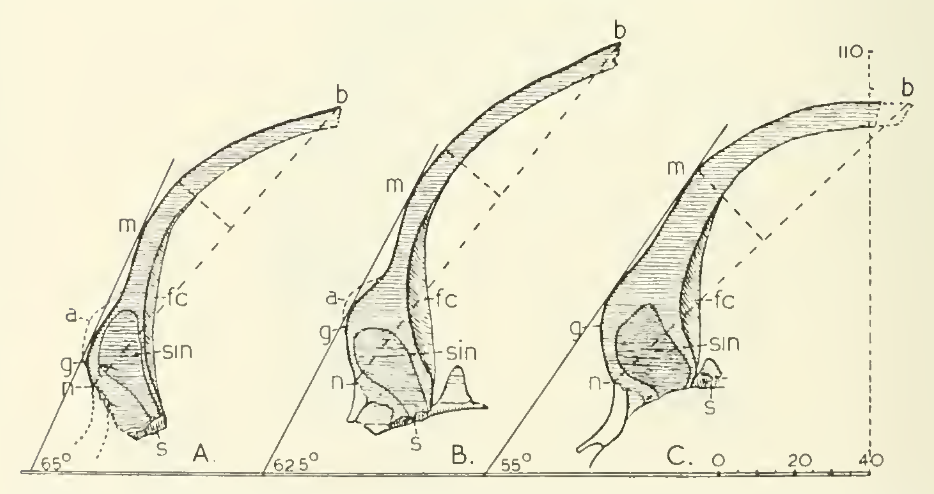


Fig. 184. Sagittal Section of the Frontal Bone. A, Tabūn I; B, Galilee; C, Gibraltar. *n*, nasion; *g*, glabella; *a*, supra-orbital projection of torus lateral to glabella; *b*, bregma; *fc*, frontal crest; *sin*, frontal sinus; *s*, septal crest formed by the frontals; *m*, metopion. The frontal angle is indicated.

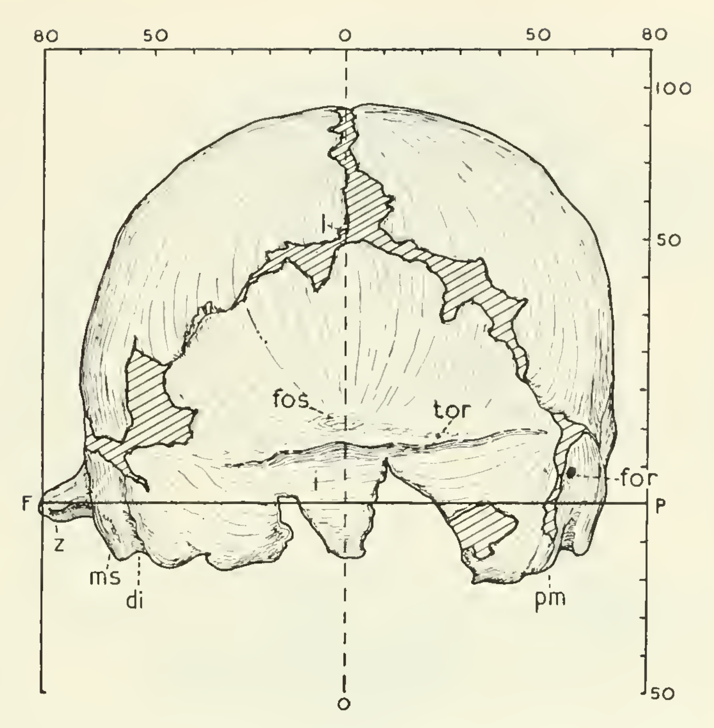


Fig. 185. Tabūn I, in Norma Occipitalis. *l*, lambda; *tor*, occipital torus; *fos*, supra-inial fossa; *z*, zygomatic arch; *ms*, mastoid process; *di*, digastric fossa; *pm*, paramastoid eminence; *for*, mastoid foramen. Defective areas are shaded obliquely.

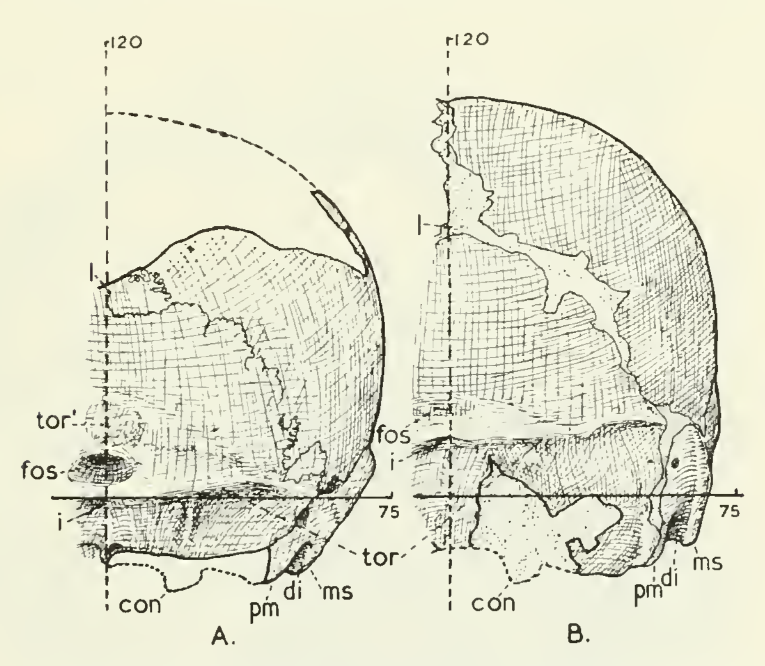
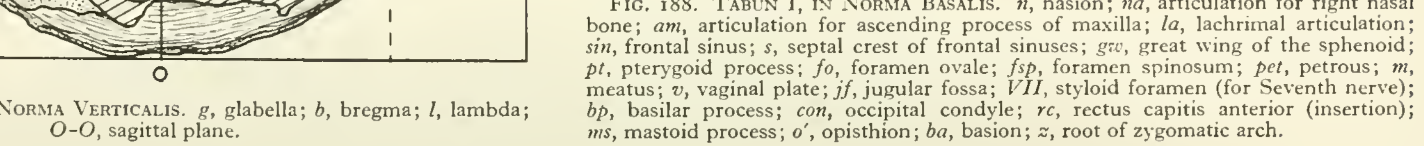


Fig. 186. Occipital Aspect of the Right Half of A, Gibraltar; B, Tabūn I. *l*, lambda; *fos*, supra-inial fossa; *i*, inion; *tor*, torus occipitalis; *tor'*, rough area within the supreme nuchal lines; *ms*, mastoid; *di*, digastric fossa; *pm*, paramastoid eminence; *con*, position of occipital condyle. Defective areas are stippled in the Tabūn skull.



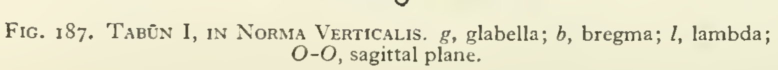


Fig. 187. Tabūn I, in Norma Verticalis. *g*, glabella; *b*, bregma; *l*, lambda; *O-O*, sagittal plane.

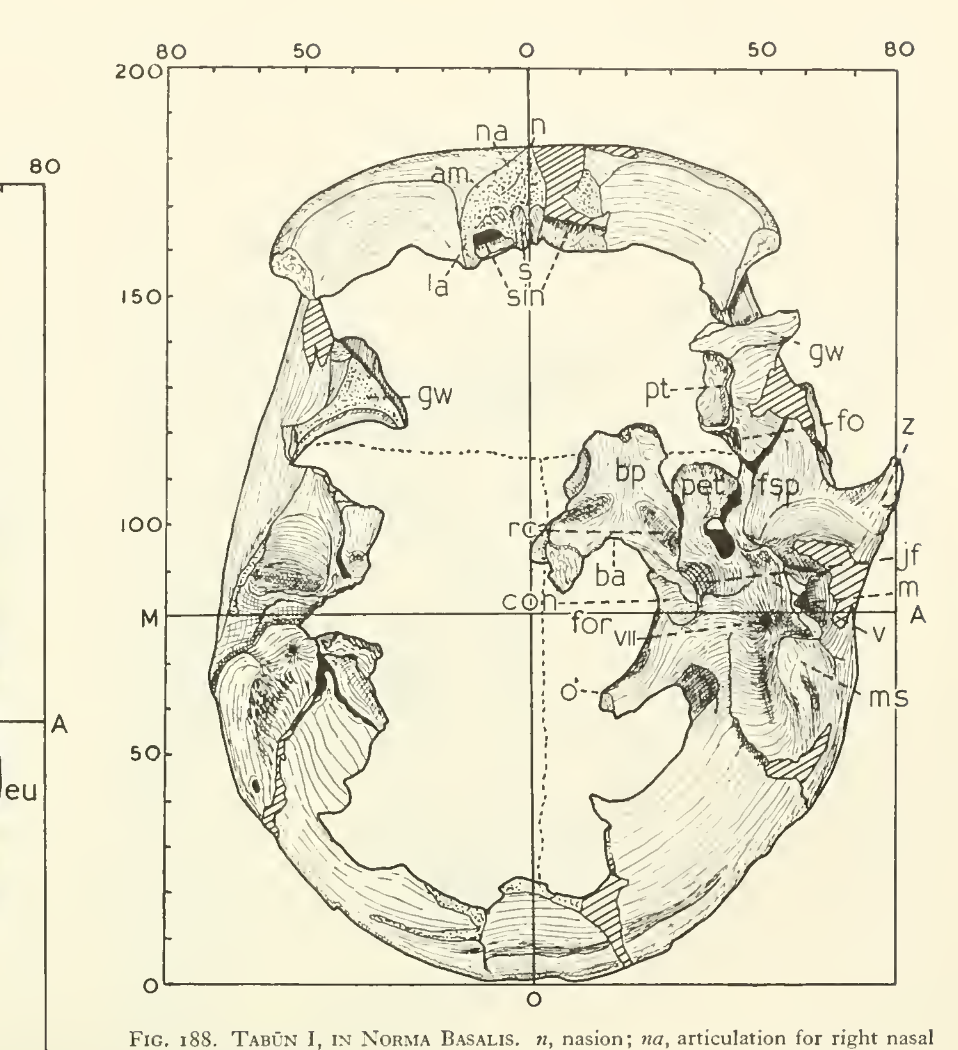


Fig. 188. Tabūn I, in Norma Basalis. *n*, nasion; *na*, articulation for right nasal bone; *am*, articulation for ascending process of maxilla; *la*, lachrimal articulation; *sin*, frontal sinus; *s*, septal crest of frontal sinuses; *gw*, great wing of the sphenoid; *pt*, pterygoid process; *fo*, foramen ovale; *fsp*, foramen spinosum; *pet*, petrous; *m*, meatus; *v*, vaginal plate; *jf*, jugular fossa; *VII*, styloid foramen (for Seventh nerve); *bp*, basilar process; *con*, occipital condyle; *rc*, rectus capitis anterior (insertion); *ms*, mastoid process; *o'*, opisthion; *ba*, basion; *z*, root of zygomatic arch.

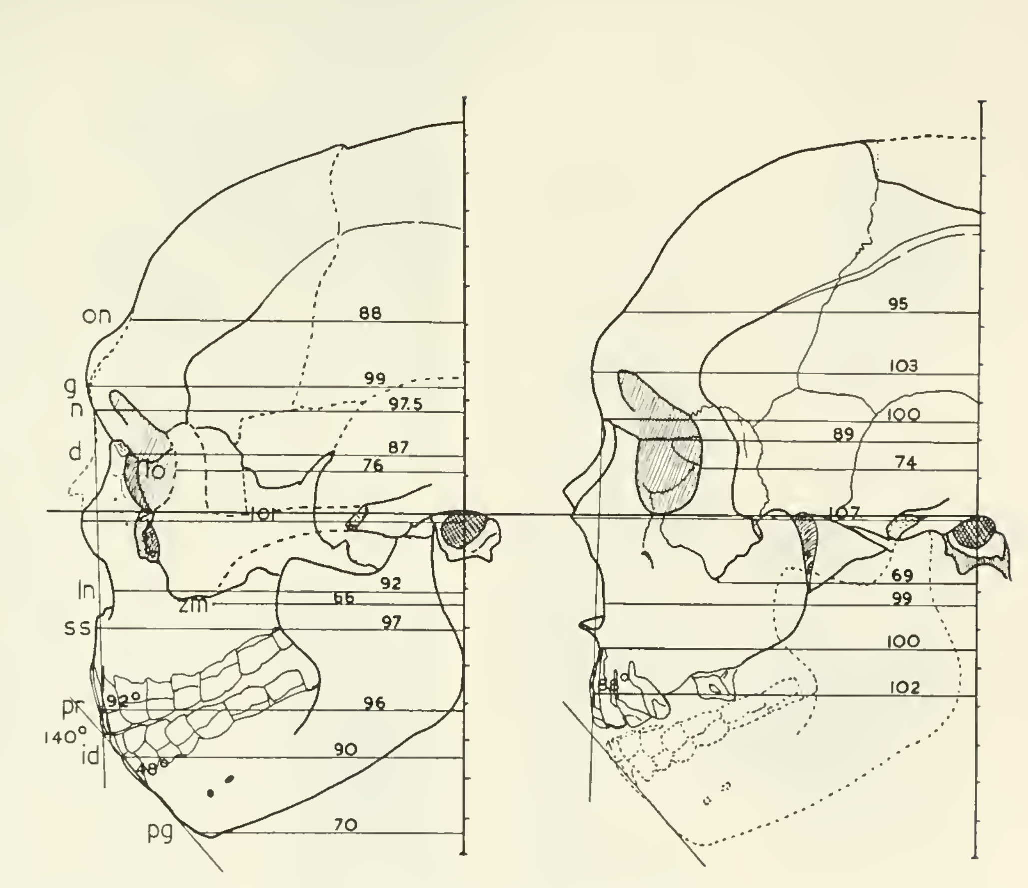


FIG. 189. TABŪN I, IN NORMA FRONTALIS. *b*, bregma; *n*, nasion; *d*, dacryon; *am*, ascending process of maxilla; *ln*, lateral nasal margin; *ns*, nasal spine; *ms*, mastoid; *pt*, pterygoid process. Defective areas are shaded obliquely. Other letters as in Fig. 168.

FIG. 190. LATERAL ASPECT, IN OUTLINE, OF THE PRE-AURICULAR HALF OF THE SKULL AND FACE TO SHOW THE PROJECTION OF VARIOUS POINTS IN FRONT OF THE MID-AURICULAR PLANE. A, Tabūn I; B, Gibraltar. The stippled outline of the mandible shown in the Gibraltar cranium (B) is taken from the mandible of Tabūn I (A). The letters have the same significance as in Figs. 172, 173.

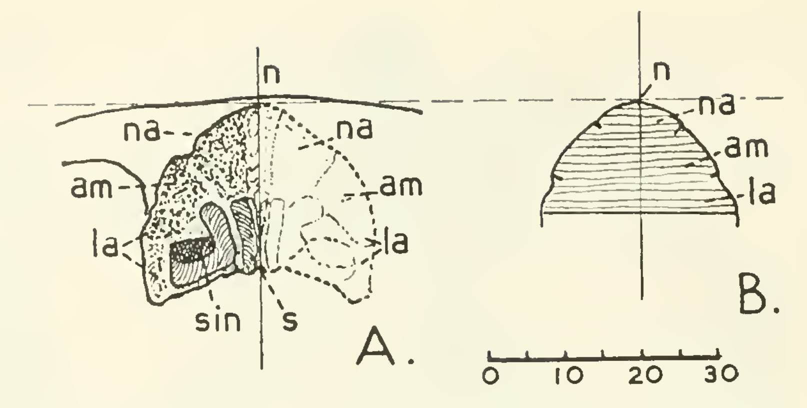


Fig. 191. Inferior Aspect of the Inter-Orbital Process of the Frontal. A, Tabūn I; B, Gibraltar (in outline). *n*, nasion; *na*, nasal articulation; *la*, lachrimal articulation; *sin*, frontal sinus; *s*, septal crest; *am*, articulation for ascending process of the maxilla.

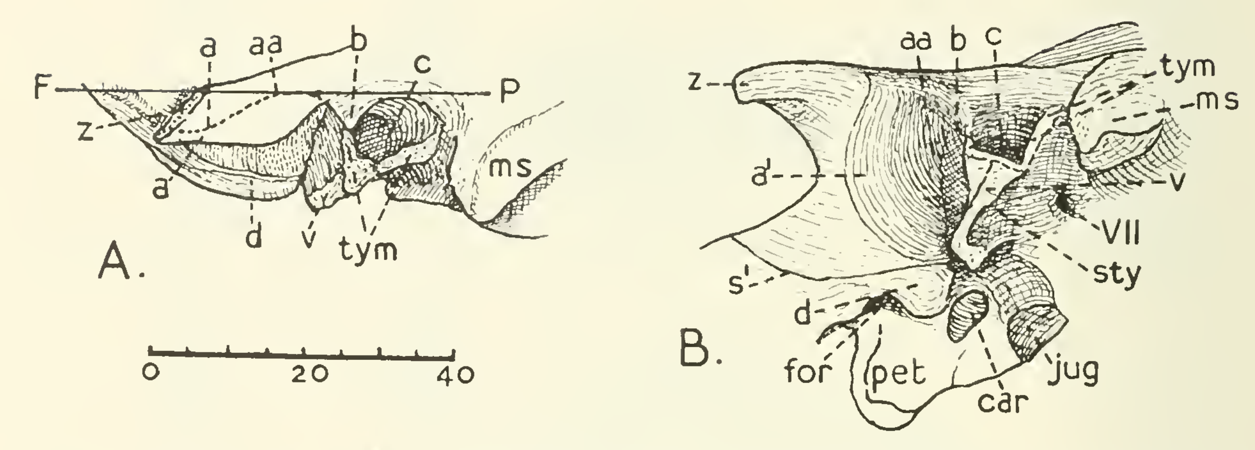


Fig. 192. Lateral and Basal Aspects of the Temporo-Mandibular Region of Tabūn I. *z*, root of zygomatic arch; *a*, articular eminence (lateral aspect); *a'*, deepest median point of articular eminence; *aa*, highest point of cavity; *b*, post-glenoid spine; *c*, meatus; *tym*, tympanic plate; *ms*, mastoid process; *s'*, spheno-temporal suture; *d*, sphenoid spine; *for*, foramen spinosum; *sty*, root of styloid process; *v*, crest of vaginal plate; *car*, carotid canal; *jug*, jugular fossa; *pet*, crushed apex of the petrous; VII, styloid foramen (for Seventh nerve).

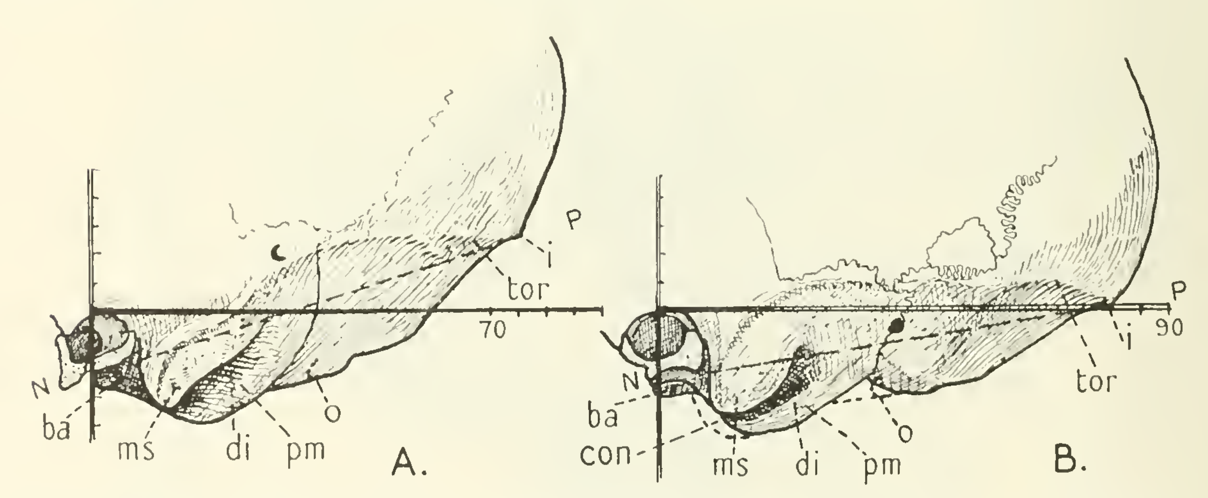


Fig. 193. Lateral Aspect of the Lower Post-Auricular Region of the Skull. A, Tabūn I (reconstruction); B, Gibraltar. *N P*, nuchal plane; *ba*, basion (position); *con*, occipital condyle; *ms*, mastoid process; *di*, digastric fossa; *o*, position of opisthion; *tor*, occipital torus; *i*, inion; *pm*, paramastoid eminence.

CHAPTER XVII

CRANIAL AND FACIAL CHARACTERS OF SKHŪL IV

(Plates XX, XXI; Figs. 194–9)

WE are now to describe the head of the man who is most representative of the Skhūl type of ancient Palestinian, a type in which the majority of the features of skull, body, and limbs are Neanthropic, as distinct from Palaeoanthropic or Neanderthaloid. Skhūl IV was a man of about 1,738 mm. (5ft. 8·4 in.) in stature (estimated from the femora), about forty-five years of age (inferred from the state of the teeth and the cranial sutures), with a big brain and a massive face. Indeed, when we recall the antiquity of his geological horizon we are surprised with the modernity of so many features of his face and body.

As will be seen from Pl. XXI D, the skull of this individual, when cleared of the breccia in which it was embedded, was found to have been subjected to great earth pressure. The skull rested on its base with the vault directed upwards, the cranial cavity was filled with earth before it had attained its cement-like hardness, the vault had become crushed downwards, the base thrust upwards within the skull and the entire face forced forwards and upwards, the main break occurring across the orbits.

The skull is shown in Pl. XX after the interior had been freed from breccia. In our figures it will be noted that there is a blank in the glabellar region of the reconstructed skull. This region in the specimen before preparation was the site of a sagittally directed fracture which evidently had played its part in the disintegration of the interorbital and glabellar parts of the frontal bone. The fragments which remained represented thin flakes of the outer tabular surface of the skull, so fragile that they crumbled when we handled them.

We believe that we have succeeded in giving to our restoration a close approximation to its original shape, but we are quite aware that certain features are problematical, particularly the degree to which the temporal bones have been displaced in a forwards and upwards direction. The region of the nasion and glabella is another important defective area. Nevertheless, we are confident that we have made available for study all the more important characters of this ancient skull.

SUTURES; THICKNESS OF VAULT

The sutures are, unfortunately, not well preserved, the bone being defective along the whole course of the coronal and in the forward part of the sagittal suture. The latter appears to have been obliterated except where it approaches the lambda (Fig. 198). The course of the lambdoid suture can be traced, the pattern was evidently complex and it was in process of being ossified (Fig. 196). The squamous and other sutures around the temporal bone were open. In spite of the ossified state of the sutures, the teeth were worn to a remarkably slight degree (p. 201).

The walls of the cranial cavity vary in thickness from 5 to 10 mm. The frontal, at the ophryon, is 10 mm. thick, above the ophryon, 8 mm. The parietal bones, where they

enter into the lateral wall of the cranium, are 6 mm.; at the parietal eminence, 10 mm. The frontal, over the third frontal convolution, is 5 mm. thick. Over the left occipital pole the bone measures 8 mm. The frontal bone above the ophryon, when the internal frontal crest is included in the measurement, has a thickness of 15 mm.; at the region of the glabella we estimate that the total thickness was over 21 mm. It is a thick skull and yet it would not be difficult to find large modern male skulls which are equally thick.

CRANIAL DIMENSIONS

The dimensions are given in detail in Tables LXXIII–LXXV (pp. 295–6). The glabello-occipital length in the restored skull is 206 mm., the bi-parietal (maximum) width is 148 mm., but the difficulty in making exact measurements will be made clear by examining the front and back views of the skull (Figs. 196, 199). The width represents 71·8 per cent. of the length; Skhūl IV was dolichocephalic. The auricular height, as reconstructed in Fig. 194, is 114 mm. and the basi-bregmatic height was between 126 and 130 mm., the distorted base making an exact estimate impossible. In comparison with length and width, the vault of the skull was low, the basi-bregmatic height being considerably less than the width and only about 62 per cent. of the glabello-occipital length. If we apply Schwalbe's method of estimating the height to which the vault ascends above the galbello-inion plane, the absolute amount (98 mm.) approaches the mean for modern male European skulls, but this height represents only 48·5 per cent. of the total length. This proportion, although low, is much higher than is usual in European Neanderthal skulls. In La Chapelle, for example, the percentage is only 40·5, in Skhūl V Schwalbe's ratio rose to 52·6 per cent. and in the Tabūn woman it is 47·2 per cent. Thus the head of Skhūl IV was very long, absolutely wide but relative to the length and width it was low in height. It is, however, not lower than is quite common in the skulls of modern Europeans.

The brain was large; we estimate the cranial capacity to be 1,554 c.c., 36 c.c. more than in Skhūl V and about 70 c.c. above the mean for modern Englishmen. The intra-cranial length, from the frontal to the occipital pole on the left side, is 176 mm. The difference between this and the glabello-occipital length, 30 mm., represents the thickness of the glabellar and occipital cranial walls. Bone made up 14·5 per cent. of the total length, 6 per cent. more than the mean for modern male Europeans. To make use of Pearson's male inter-racial formula (Martin, 1928, vol. ii, p. 647) we reduce the length to a modern proportion, namely 194 mm., but no reduction need be made for width or auricular height. The result is a capacity of 1,554 c.c., which must be under rather than above the actual amount, for, as in Skhūl V, the capacity is very great in the post-auricular region.

We draw attention at this point to the main differences in cranial outline between the Neanderthal type of Europe and the Skhūl type, represented by Skhūl IV (Fig. 195). The bun-shaped occipital region of the Neanderthal type is due to a flattening and tilting upwards of the nuchal surface; in this respect Skhūl IV is Neanthropic. Although the chief cranial dimensions of the skulls of Skhūl IV and La Chapelle are very similar, their profiles are very different, especially in the frontal and facial regions. The frontal angle of La Chapelle is more oblique, being 57°. In Skhūl IV the frontal eminence is apparent, the frontal angle being 62°. The chief difference lies in the position of the face. In La

Chapelle the face is truly prognathous whereas in Skhūl IV it is bent backwards under the base. The facial angle in the former is 82°, in the latter it is 97°, ultra-orthognathous. There is practically no chin in La Chapelle, the gnathic angle being 61°, whereas in Skhūl IV the chin is well developed with an angle of 71°. The angle of the snout or muzzle (facial plus symphysial angles) is 143° in La Chapelle; in Skhūl IV, 168° (Table LXXVII, p. 297). In outline of cranium and face Skhūl IV is Neanthropic; it might well be the prototype of the Cromagnon form.

Our drawing of the occipital aspect of Skhūl IV (Fig. 196) will give an idea of the massiveness of the specimen, and also of the degree of post-mortem distortion which we found impossible to reduce. It is evident that the sides of the skull were nearly vertical, the width of the skull being nearly as great at the base of the mastoids as higher up. The bimastoid width (Table LXXXII, p. 298) we estimate to have been 141 mm. The mastoids were nearly vertical in position. The lambdoid suture, so far as it is preserved (Fig. 196), was Neanthropic in its pattern and in its shape. How much the nuchal surface of the occipital has been pressed within the cerebellar chamber will be seen from Fig. 196, where its original position is indicated by a broken line.

Although the surface of that part of the occipital bone which carries the nuchal lines is not well preserved, yet the preservation is sufficiently good to assure us that there was no formation which could be called an occipital torus. There is the indication of an external occipital protuberance (Fig. 194, *i*) and the upper limit of the attachment of the neck muscles is marked, not by a bony bourrelet, but by a sharply marked ridge or line. These are indications of a Neanthropic character.

Certain features to which we desire to call attention are shown in the tracing of the vertex view of Skhūl IV (Fig. 198). The first is the width and forward projection of the supra-orbital torus or shelf. In width it is 133 mm., 9 mm. more than in the La Chapelle skull. Indeed, only in the Rhodesian skull do we find this measurement exceeded. And yet, as we shall see when we come to deal with the face, the torus in Skhūl IV has lost many of the points we find in typical Neanderthal skulls. As reconstructed, the glabella projects 13 mm. in front of the ophryon; at its more lateral part the toral projection is 12 mm.

The minimum frontal width is 106 mm., rather less than the same diameter in La Chapelle but very much greater than the other Palestinian skulls described here (Table LXXIV, p. 296). The extent to which the supra-orbital width exceeds the minimum frontal is an index to the development of the temporal muscles; here the excess is 27 mm. This figure stands nearest to the Rhodesian record, 41 mm.

The other width measurements given in Table LXXIV (p. 296) are in nowise peculiar. In our reconstruction the maximum width of the frontal is 121 mm., which represents 81·7 per cent. of the maximum width of the skull. The frontal width between the elevation caused by the third frontal convolution is 114 mm.; in the Galilee frontal this diameter is 113 mm.

In spite of the many Neanthropic features exhibited by this skull, those familiar with the outline of Neanderthal crania will recognize that there are also distinct resemblances to that type.

ARCS AND CHORDS OF THE VAULT

In Table LXXVI (p. 296) are given the measurements of the arcs and chords of the bones which form the vault and also the circumferences. Unfortunately we cannot

measure the chord of the occipital owing to the inflection and distortion of its basal part. The total sagittal arc must have been about 403 mm., 70 mm. more than in Tabūn I and 30 mm. more than in Skhūl V. The coronal arc, from porion to porion, measures 315 mm., while the circumference of the skull, measured above the level of the supra-orbital torus, is *c.* 580 mm.

SPHENO-TEMPORAL REGION

In connexion with Skhūl V and Tabūn I we have given a description of that part of the floor of the temporal area of the skull formed by the orbital plate of the malar and the great wing of the sphenoid. We found in these two skulls that the spheno-temporal suture was relatively far back and that the great wing and the orbital plate were absolutely and relatively wide, as in typical Neanderthal skulls. There is some measure of doubt as to the exact position of the orbital margin of the malar (Fig. 194), but, making allowance for this, the orbito-squamous distance in Skhūl IV is great and the arrangement of the parts is much as in the two Palestinian skulls already described. The orbital margin of the great wing (Fig. 194 *gw*) is preserved in part and the least width of the great wing can be measured. It is 20 mm., which is 7 mm. more than in Skhūl V, but only 1·5 mm. less than in the Galilee skull. The orbital plate of the malar was wide, and owing to the position of the ascending malar process was extensively exposed on the floor of the temporal fossa (Fig. 194). The squamous margin of the temporal is missing, but it was apparently arched and relatively high. In the spheno-temporal region of Skhūl IV, we seem to have a form which is transitional between the Palaeoanthropic form and the type seen in living races.

ANTERIOR ASPECT OF THE FACE

An anterior view of the face is shown in Fig. 199 and Pl. XX. The dominating features are the great width of the supra-orbital torus (133 mm.), the great prominence of the malar bones and an extreme bi-zygomatic width (160? mm.). The malar prominences are quite unlike anything to be seen in Neanderthal skulls, representing an exaggeration of a condition found in primitive Neanthropic races such as Australians and Bushmen. The mandible at the angles was also very wide, 110 mm. On the other hand, the width of the upper jaw measured between the lower ends of the malo-maxillary sutures was small (92 mm.) relative to the bizygomatic width. The corresponding breadth in Skhūl V was 110 mm. (Table LXXVIII, p. 297). The maxillary breadth, measured between the alveolar margins above the second molars, was great, 75 mm. The area and depth of the palate (cf. Chapter XIII) are also very great. Especially massive is that part of the upper jaw which is situated between the naso-spinal point and the incisive alveolar margin. The diameter from the tip of the nasal spine to the alveolar margin is 29·5 mm., virtually the same as in La Chapelle (29·3 mm.) and about 4 mm. greater than in the Gibraltar face. Measurements of the face are given in Table LXXVIII (p. 297), some of these being necessarily based upon the intact left half.

The total height of the face, from nasion to gnathion, measures 135 mm. in the reconstruction shown in Figs. 194, 199. It is a long face, of which the maxillary or masticatory part forms an uncommonly large element. From the lower margin of the nasal opening to the gnathion it measures 80 mm., representing about 60 per cent. of the upper facial height, the nasal segment forming the remaining 40 per cent. The lower jaw at the sym-

physis has a height of 42·5 mm. This represents a proportion of the total facial height which has not been met with before in skulls of a mid-Pleistocene date with the exception of Krapina J. The height in the latter is the same, 42·5 mm. We have not only this great height in Skhūl IV, but in the region of the chin the characters are Neanthropic.

The supra-orbital torus, in spite of its great width from end to end, has not the arched, robust, and rounded form which is met with in the Neanderthal skulls of Europe and also in the Tabūn and Galilee skulls of Palestine. As will be seen from our illustrations, the torus becomes flattened from above downwards as it enters the outer, supra-orbital, segment. The two elements, supra-ciliary and supra-orbital, tend to be demarcated from each other as in Neanthropic skulls. Although at its base (medial part) the outer part of the torus is 10–12 mm. thick, as it approaches the free or lateral extremity it becomes reduced to 6 mm. In its conformation the supra-orbital torus represents a condition which is intermediate to that seen in typical Neanderthal crania and the form seen in the large Predmost male (No. 3).

The most remarkable feature of the face of Skhūl IV is his malar. This is a flat bone in Neanderthal skulls, and also in the Galilee skull, shaped as in the chimpanzee with a relatively long orbital process. In our specimen the malar is shaped as in modern primitive races. As will be seen from Figs. 194, 199, the circum-orbital element of the malar forms a rounded, forward-bulging, almost horizontal shelf. At the outer limit of the orbit it projects forwards 10·5 mm. in front of the lower orbital margin. The malar shelf is continued inwards on the ascending process of the maxilla (Fig. 199, *mal*) forming a flat field between the inner margin of the orbit and the nasal process of the maxilla. The lower or maxillary element is nearly vertical and in its contour continues outwards the sub-orbital area of the maxilla, which is also flat, being neither hollowed as in modern skulls nor inflated and convex as in the Gibraltar skull. The malar 'shelf' is developed in some primitive modern skulls, such as those of male Australians, but never to the extent seen in Skhūl IV. Skhūl IV is not Neanderthaloid in his cheek bones; an ultra-Neanthropic feature is here represented.

The malar bones were not only prominent in a forward direction but also laterally. This is best indicated by a bi-malar diameter measured between the angles (jugale) on the temporal margin of the orbit. Measured on the left half of the face it is 71 mm. indicating a total diameter of 142 mm., so far as we can learn, a record measurement. Nor could the bi-zygomatic diameter have been much under 160 mm.

Other features of the malar relate to its orbital process. In modern skulls the lateral surface is directed chiefly in an outward (lateral) direction, in anthropoids its direction is more forward than outward. This latter condition was apparently the case in Skhūl IV, if one may judge from the lower part, for the upper part is defective (Figs. 194, 199).

The ascending process of the malar is relatively weak, especially as it approaches the outer end of the supra-orbital torus. The suture formed with the external angular process is only 7·5 mm. in length. It measured 11·5 mm. in the Galilee skull. It seems probable that in the Skhūl crania, forces transmitted to the upper jaw during mastication were distributed to the vault of the skull chiefly by means of the ascending process of the maxilla, the root of the nose and the inter-orbital septum, and to a lesser degree through the malar and the malar process of the frontal. Hence the massive strength of the inter-orbital process in the Skhūl and Tabūn crania.

THE NOSE

As will be seen in Fig. 199, a fracture crosses the face to reach the left orifice of the nasal aperture. There is a medial displacement of the upper fragment to the extent of 2 mm., but the original width of the nasal opening can be measured accurately. It was 30 mm., Skhūl IV being wide nosed as is usually the case with Neanderthal skulls (Table LXXX, p. 298). The nasal height is problematical, but was about 55 mm., the width being *c.* 54·5 per cent. of the height, a relatively wide nose.

The entrance to the floor of the nose is peculiar (Fig. 199). The bony threshold is raised so as to form a bar or ridge. Behind the bar, which rises 5 mm. above the level of the nasal floor, open the two naso-palatine canals, each canal appearing just lateral to the bony septum and immediately behind the nasal spine. The raised threshold of the nose is made up of two elements, the chief of the two being the inner naso-spinal element (Fig. 199 r^1) which reaches such a high development in the Gibraltar nose. The second element, the outer naso-spinal ridge (Fig. 199 r^2) is weakly developed, both from the lateral nasal margin and from the spinal margin, the paraseptal fossa being scarcely delimited anteriorly.

The nasal spine, which is strong and blunt, forms the anterior part of the septal ridge. Part of the septum formed by the vomer is still *in situ*. It will be seen (Fig. 199) that the anterior part of the nasal septum was deflected to the left side, as happens so often in modern Europeans.

Perhaps the most remarkable of all the nasal features of Skhūl IV relates to the prominence of the upper nose. Nasal prominence seems to be late in its evolution, reaching its highest development among Caucasian or white people. Such prominence depends (1) upon the hypertrophy of the nasal processes of the maxilla; (2) on the size and strength of the nasal bones. In Skhūl IV we can say nothing about the nasal bones except in so far as we may be guided by their relationships to surrounding parts. The ascending process of the left maxilla carries the border which came into union with the lateral margin of the nasal bone. We infer from this source of information that the bridge formed by the two nasal bones had a span which was 16 mm. wide, a wide span but not so great as in Tabūn I. To the height of the bridge we have no clue nor to its shape in profile, but we suspect that the resemblances were similar to Skhūl V rather than to Tabūn I. We shall return to the prominence of the nose when we discuss the facial profile.

ORBITS

A glance at Fig. 199 will show that few exact measurements are possible in the orbital region of Skhūl IV. The bi-orbital width measured by calipers between the inner ends of the fronto-malar sutures reaches the exceptionally high figure of 117 mm. In our reconstruction we have had to make the inter-orbital process of the frontal 33 mm. to accommodate the width indicated by the two ascending maxillary processes. The width of the left orbit we estimate to have been 44 mm., its height 34 mm. (Table LXXX, p. 298).

FACE IN PROFILE

In the recognition of one race from another we are guided by many aspects of the body and face, especially by the facial features seen in profile. We count it, therefore, a matter

of importance to measure and to make a graphic record of the forward projection of the facial features. Now in the profile of Skhūl IV (Figs. 194, 195) there is one feature which stands out from the others because of its individuality, and this is the extent and prominence of the ascending process of the maxilla. Measurements relating to the degree to which facial features project in front of the mid-auricular plane are given in Table LXXIX (p. 297) and depicted in Fig. 195. It should be noted that in their degree of projection and also in their form the ascending processes of the maxilla in Skhūl IV agree closely with those of La Chapelle (Fig. 195). The projection in Skhūl IV is 116·5 mm., in La Chapelle 118 mm. Yet the prominence of the nose is apparent in Skhūl IV, while this is not the case in La Chapelle.

The explanation is to be seen in Fig. 195, where their profiles are superimposed. The jaws of La Chapelle project forward under the nose while those of Skhūl IV are retracted, leaving the nose unsupported below and therefore prominent. For example, the projection of the prosthion in La Chapelle is 117 mm., almost the same as the nose. In Skhūl IV it is 97 mm., 19·5 mm. less than the ascending process of the maxilla. The retraction of the jaws does certainly bring out the prominence of the nose, but the nasal projection is not simply a matter of jaw reduction. There is a positive growth in all parts of the nose, sides and roof, and no element enters so fully into the evolution of the Caucasian nose as the ascending processes of the maxilla. In the great nasal development of Skhūl IV we find another justification for regarding him as a proto-Caucasian, or what is an equivalent, a proto-Cromagnon.

We have just mentioned that the projection of the prosthion measured from the mid-auricular plane is 117 mm. in La Chapelle, while it falls to 97 mm. in Skhūl IV. It is 110 mm. in Skhūl V. The absence of sub-nasal prognathism in Skhūl IV as well as in Tabūn I is an interesting fact. The prosthion lies behind the subnasal point in both of them, whereas in La Chapelle and in Skhūl V it lies in front of the latter. More striking still, as shown in Fig. 195, is the falling back of the mandibular points, the infradental and the pogonion, in Skhūl IV as contrasted with La Chapelle. It will be noted that while the gonion of La Chapelle corresponds with that of Skhūl IV the infradental and pogonion of the former lie 12 mm. and 6 mm. respectively in front of the same points on the mandible of Skhūl IV. Undoubtedly the greater recession of the alveolar element of the mandible, as compared with the basal or chin element, does account for the production of a mental eminence. But as in the production of a nose by recession of the alveolar element of the maxilla this process has to be accompanied by a positive nasal growth, so too in the production of a chin there has to be a positive growth in addition to the recession of the alveolar element. We have all of these factors at work in Skhūl IV in producing the nose and chin of a Neanthropic man of the Cromagnon or Caucasian type. Some of the changes have already been discussed in the chapter on the Mandible.

The forward projection of the glabellar region in Skhūl V was remarkably small for so large a cranium, only 99·5 mm., this being nearly the same as in the much smaller Tabūn skull. The glabellar projection in La Chapelle is 113 mm., in Skhūl IV 111 mm., in the Old Man of Cromagnon 111 mm., in the Predmost male 108 mm. We have no certain indication of the position of the nasion in Skhūl IV, but in our reconstruction we have placed it 106 mm. in front of the mid-auricular plane. This is 30 mm. in front of the lateral orbital point. The difference was only 15 mm. in Skhūl V, an indication of a

flat face. The difference is 27 mm. in La Chapelle, in Gibraltar 27 mm. These higher measurements indicate a face which is angle or wedge shaped, the ridge of the nose representing the edge of the wedge, the orbital margins its base. In spite of his great facial width, Skhūl IV had a wedge-shaped upper face.

MASTICATORY SYSTEM

We have evidence of the great development of the muscles of mastication in the size of the palate (p. 201), in the width of the ascending ramus of the mandible (p. 219), and in the extent to which the supra-orbital width exceeds the minimum frontal diameter. This inference is also supported by the great projection of the zygomatic arches and by the strength of the malar bones. There is a point mentioned in the previous paragraph to which we might have alluded, and that is the forward position of the malar process of the maxilla. The lower end of the malo-maxillary suture, which we may take as the anterior limit of the zygomatic arch, is 77 mm. in front of the mid-auricular plane. The distance in La Chapelle is 72 mm. On the other hand, the extent of the origin of the temporal muscle from the side of the skull was in no way exceptional. The lower temporal line rose to 85 mm. above the Frankfort plane, and the distance from the temporal line to the sagittal suture was 67 mm. (Table LXXXI, p. 298). These measurements are not exceptional.

TEMPORO-MANDIBULAR REGION (Pl. XVIII)

The temporo-mandibular joint in both Skhūl V and Tabūn I had modern or Neanthropic features and in Skhūl IV all the Neanthropic features become accentuated. In Fig. 197 is shown a drawing of the lateral aspect of the temporo-mandibular region of the left side. The first feature which strikes the observer is the extent, the verticality, and the strength of the tympanic plate. It forms a hinder rampart for the joint. The height of the plate from the petro-squamous suture to its free edge is 20 mm., as against 10 mm. in the Gibraltar skull and 13 mm. in an Australian skull. The length of the plate from the auricular margin to the medial apex is 30 mm., in the Gibraltar skull 27·5 mm., in an Australian 28 mm. The free auricular edge is straight, 17 mm. long and 5 mm. wide. All of these features are ultra-Neanthropic.

To the eye the glenoid cavity seems very capacious (Pl. XVIII c). At all parts, even on the articular eminence, it is concave from side to side. It is deeply concave in an antero-posterior direction save for the slight convexity of the anterior part of the articular eminence. Only a thin paperaceous lamina of bone separates the roof of the cavity from the temporal lobe of the brain. The post-glenoid spine forms a posterior buttress 7 mm. in depth behind the roof of the fossa. The cavity rises to a slightly higher level than the roof of the meatus (Fig. 197). The mid-point of the articular eminence is only 6 mm. below the highest point of the articular cavity (Fig. 197, *a′*, *aa*), while the lateral margin of the articular eminence is marked by a tuberosity on the free margin of the root of the zygoma which descends 6 mm. below the Frankfort plane. The sagittal diameter of the cavity, measured from the anterior border of the articular eminence to the free edge of the tympanic plate, is 34·5 mm. and the maximum transverse width is 24 mm. The axis of the joint runs inwards and slightly backwards.

If Fig. 197 be compared with Figs. 175 and 192, it will be noted that in the Gibraltar and Tabūn crania the medial part of the articular surface descends to form a prominent

tuberosity, whereas in Skhūl IV this tuberosity is only slightly below the articular eminence (Fig. 197, *b'*). In all its features, the temporo-mandibular region of Skhūl IV is Neanthropic.

AUDITORY MEATUS

The form of the auditory meatus is shown in Fig. 197. It is somewhat difficult to measure, but that its height greatly exceeds its antero-posterior diameter, as in Neanthropic skulls, is very apparent. If we measure the diameters at the free margin of the tympanic plate, then the height of the meatus is 15 mm., its antero-posterior diameter 7·5 mm., but if we measure where the passage becomes narrower, then the height is 10 mm., and the width 7·5 mm. The cranial width between the outer margins of the tympanic plates is 111 mm. and between the poria 133 mm. Notwithstanding the Neanthropic characterization of the tympanic region, one Palaeoanthropic feature remains. The post-vaginal part of the tympanic plate is extensive and the opening for the facial nerve lies 10 mm. behind the edge of the vaginal ridge, whereas in modern skulls the distance is usually only half this amount. The root of the styloid had been ossified; its broken slender stump can still be seen.

NUCHAL AREA

We found evidence of a stout neck in Skhūl V, one that was both wide and deep. Skhūl IV was not so tall as Skhūl V and the measurements show that his neck was not so thick from back to front as in Skhūl V (Table LXXXII, p. 298). Nevertheless, its width measured between the bases of the mastoid processes was very great, 141 mm. as against 130 mm. in Skhūl V. The area of nuchal fixation must have been equally great. Owing to the crushed condition of the nuchal plate of Skhūl IV, it is not possible to decipher the muscular areas, but those for the lesser straight muscles are present, as is the posterior margin of the foramen magnum.

The apical part of the mastoid process is preserved on the left side (Fig. 197). It descends 26 mm. below the level of the upper margin of the auditory meatus and is intermediate in form and size to the Palaeoanthropic and Neanthropic types. The digastric fossa is a wide groove, bounded medially by the paramastoid, which, it will be noted, does not descend as low as the tip of the mastoid. The opposite condition is usual in Neanderthal skulls.

Although the base is represented by fragments of bone, embedded in a substratum of breccia, nothing useful can be made out, except as regards the basilar plate of the occipital. Part of this is present. Its width, between the rough areas of the petrous bones, near the mid-point of its length, was 27 mm. At this point it had a thickness of about 12 mm. Clearly the basilar process was of great strength.

SUMMARY

The skull of Skhūl IV was of great length and width but of relatively low height. Its cranial capacity is estimated to have been 1,554 c.c. The curves of the forehead and the occiput are not those which are characteristic of the Neanderthal skulls of Europe, but agree with Neanthropic types in these respects. Yet there is a supra-orbital torus which, although prominent, exhibits features which show a tendency to assume the form seen in early Europeans, such as the men of Predmost. The face is long and remarkably wide, especially in the zygomatic regions. The cheek bones are unlike those found in Neander-

thal crania and appear to represent a primitive Neanthropic form. The nose was wide and prominent. The upper face is hyper-orthognathous, this being due to the bending back of the face under the base of the skull as is common in many modern Europeans. The lower jaw is deep at the symphysis and has a well-developed chin. The area of the palate is particularly great. The temporo-mandibular joint has a deep glenoid cavity and a very large tympanic plate, the form of the parts being that found in strong-jawed Neanthropic skulls. The external auditory meatus and the mastoid have the form seen in Neanthropic races. In the sphenoid and neighbouring regions certain Neanderthal traits are to be detected, but in the majority of his cranial characters Skhūl IV was modern. The resemblances to the Cromagnon type of southern France are more numerous and impressive than are those to the Neanderthal cranial type, taking the La Chapelle skull as a representative.

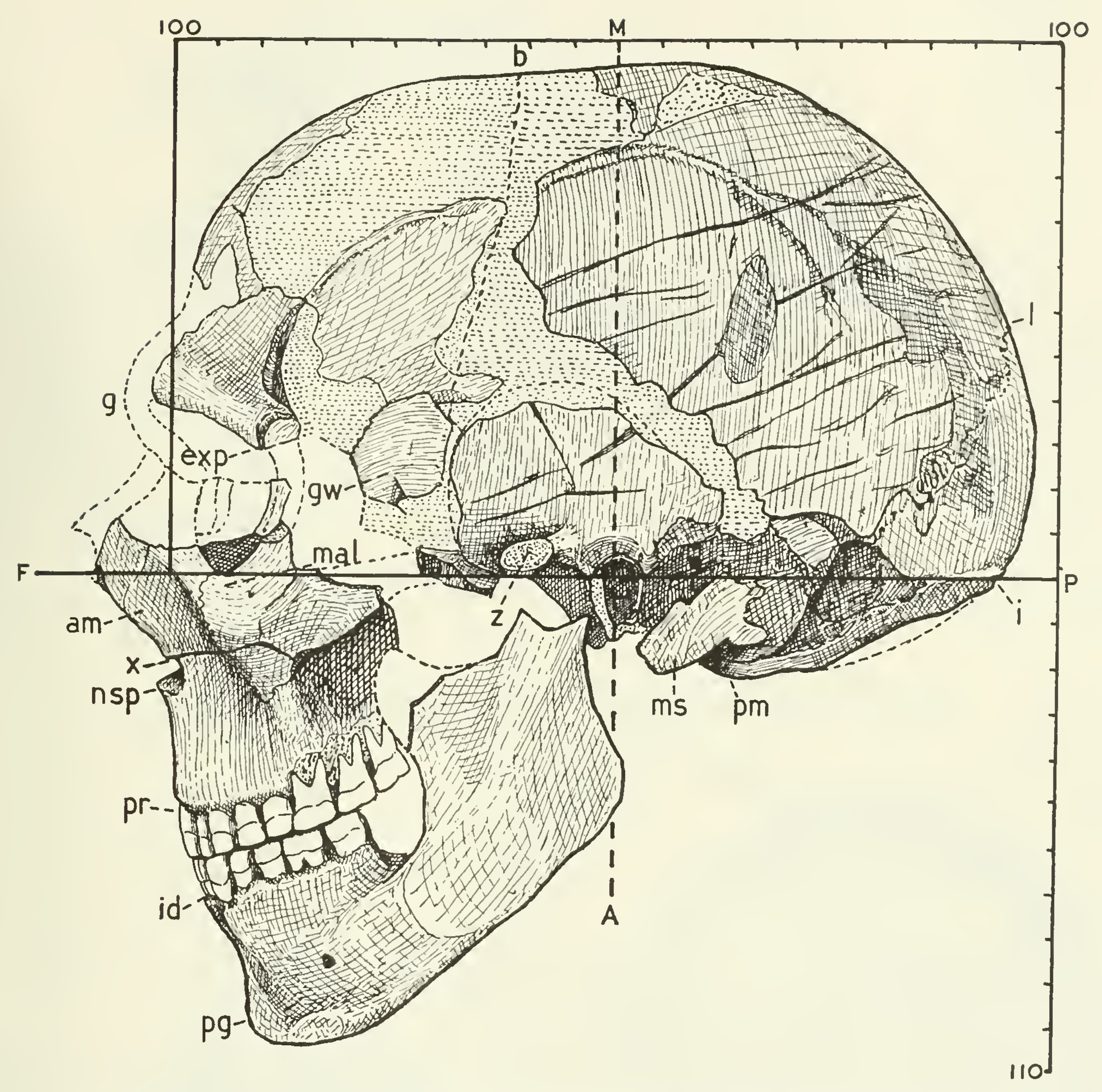


Fig. 194. Skhūl IV, in Norma Lateralis (Reconstruction). The position of the Frankfort plane is approximate, being drawn from the orbitale to the inion. The temporal bone and the ear have been displaced forwards and upwards by the compression of the base of the skull. Defective areas are stippled. *exp*, external angular process; *gw*, great wing of the sphenoid; *z*, fractured base of zygomatic arch; *am*, ascending process of the maxilla; *x*, anterior end of horizontal fracture of the maxilla and malar; *nsp*, nasal spine; *pr*, prosthion; *id*, infradental; *pg*, pogonion; *mal*, shelf of malar; *g*, glabella; *b*, bregma; *l*, lambda; *i*, inion; *ms*, mastoid process; *pm*, paramastoid eminence.

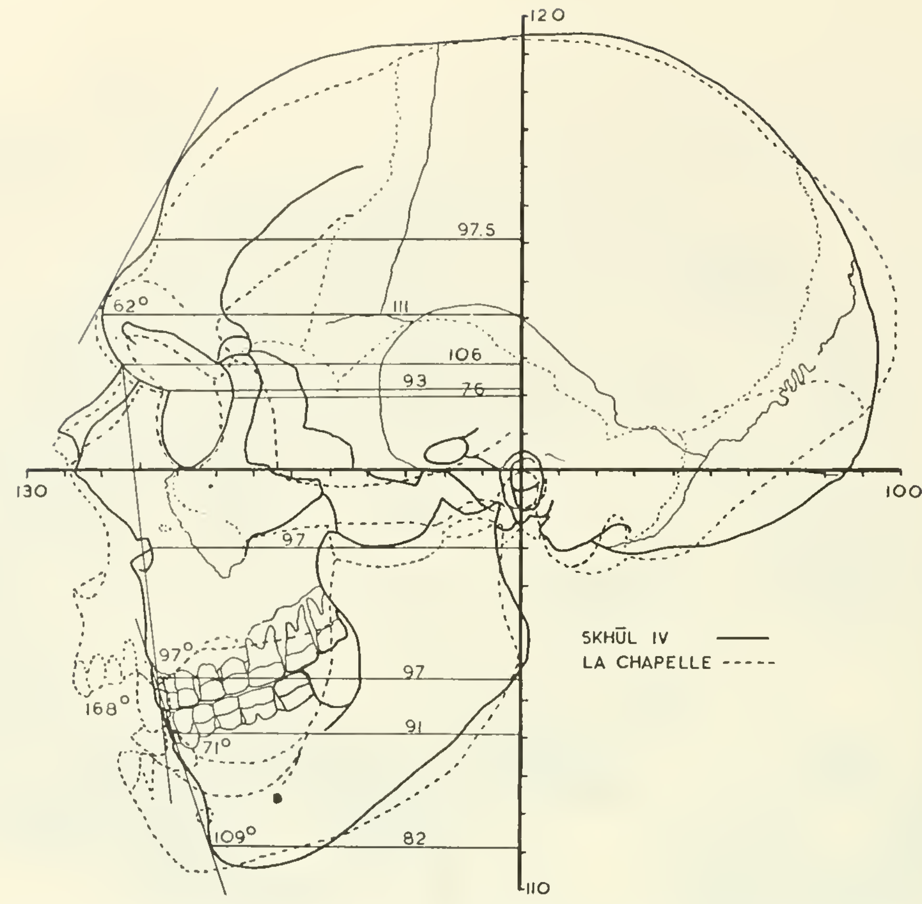


FIG. 195. SUPERIMPOSED PROFILES OF THE LA CHAPELLE (BROKEN LINE) AND SKHŪL IV (SOLID LINE) SKULLS. The facial projections in front of the mid-auricular plane and the facial, frontal, and chin angles of Skhūl IV are indicated. The projections are indicated in Fig. 172.

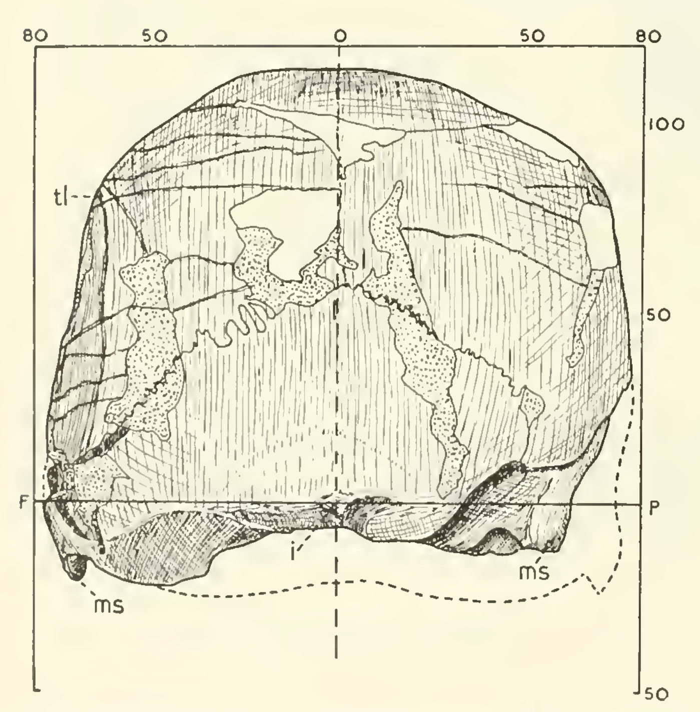


FIG. 196. SKHŪL IV, IN NORMA OCCIPITALIS. The Frankfort plane is that determined for the specimen and shown in Fig. 194. The broken line represents the original outline of the nuchal surface of the occipital bone. *i*, position of inion; *ms*, mastoid; *tl*, temporal line; *l*, lambda; the lambdoid suture is indicated.

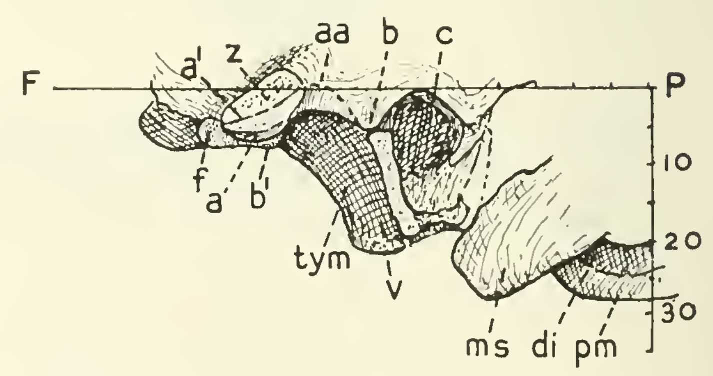


FIG. 197. SKHŪL IV. Lateral aspect of the region of the left temporo-mandibular joint and of the ear. *z*, root of zygomatic arch; *a*, articular eminence (lateral part); *a'*, deepest point of articular eminence; *aa*, highest point of cavity; *b*, post-glenoid spine; *c*, meatus; *b'*, medial glenoid (temporal) tuberosity; *tym*, tympanic plate; *v*, vaginal ridge; *ms*, mastoid process; *di*, digastric fossa; *pm*, paramastoid eminence.

Fig. 198. Skhūl IV, in Norma Verticalis. The Frankfort plane is that used in Figs. 194, 196. Defective (restored) areas are shaded obliquely, others are stippled; *b*, position of bregma; *l*, lambda; *z*, root of left zygoma; *exp*, external angular process; *mal*, malar; *tl*, temporal lines; *am*, ascending process of maxilla; *M*, position of meatus.

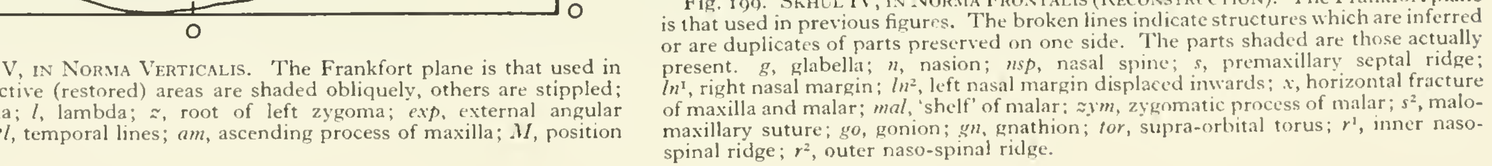


Fig. 199. Skhūl IV, in Norma Frontalis (Reconstruction). The Frankfort plane is that used in previous figures. The broken lines indicate structures which are inferred or are duplicates of parts preserved on one side. The parts shaded are those actually present. *g*, glabella; *n*, nasion; *nsp*, nasal spine; *s*, premaxillary septal ridge; ln^1, right nasal margin; ln^2, left nasal margin displaced inwards; *x*, horizontal fracture of maxilla and malar; *mal*, 'shelf' of malar; *zym*, zygomatic process of malar; s^2, malo-maxillary suture; *go*, gonion; *gn*, gnathion; *tor*, supra-orbital torus; r^1, inner naso-spinal ridge; r^2, outer naso-spinal ridge.



CHAPTER XVIII

CRANIAL AND FACIAL CHARACTERS OF SKHŪL IX, II, VI, VII

(Plate XXI, Figs. 200–12)

WE have considered at some length in the previous chapters two male skulls, IV and V, from the Mugharet es-Skhūl and the skull of the woman from et-Tabūn. We shall now turn our attention to the less-well-preserved crania, all from the Skhūl cave, touching upon the significant points in their anatomy and emphasizing their relationships to the better-preserved specimens.

SKHŪL IX

We have already described the upper part of the left femur of this individual and also the pelvis, of which the left side is the more complete (p. 73). The femur is remarkably stout, its shaft being flattened dorso-ventrally. This man was probably not so tall as the two Skhūl men whose skulls we have previously described, but his cranium is the most massive of the three. As reconstructed in Fig. 200 the length is 213 mm., a record for Palaeolithic man. We estimate the width to have been 145 mm., the width being 68 per cent. of the length, giving an extremely dolichocephalic skull. The height of the vault above the Frankfort plane we have determined as 116 mm., a moderate measurement in itself but low in relationship to the length. The auricular height is only 54·4 per cent. of the length, almost the same proportion as in that typical Neanderthal skull, La Chapelle. Thus, as in most of the Mount Carmel people, the skull is low roofed. As in the others, the width of the brain containing part of the skull of Skhūl IX is much greater than the height of the cranium (Fig. 201). The cranial capacity we estimate to have been 1,587 c.c., about 100 c.c. more than the mean for modern Englishmen and 33 c.c. more than his nearest rival among the Skhūl men, Skhūl IV.

This brief summary of our estimates rests on data which we shall now lay before our readers. All our measurements had to be made on our reconstruction because of the manner in which the skull had been broken and, in part, distorted. The parts of the skull which were recovered are shown in Figs. 202, 203, 205, 206, 207, which are accurate tracings of five aspects of the skull, right and left lateral, vertex, occipital, and face. These have been arranged on what is approximately the Frankfort plane with the frontal fragment so placed as to give the skull a length of 206 mm. No part of the base was recovered. The defective areas on the right side are extensive, beginning in the region of the malar in front and extending backwards to the mastoid, and upwards to the temporal lines on the frontal (Fig. 202). On the left side the missing parts include the sphenoid, the malar, and somewhat more than half of the frontal (Fig. 203). The greater part of the anterior border of the squama is fortunately preserved as is that part of the frontal which carries the coronal suture. The position of the left auditory meatus can be fixed with some degree of certainty for the curved upper margin of the aperture, formed by the backward extension of the root of the zygoma, is easily recognized (Fig. 200). On the hinder part of the left lateral aspect, involving the parieto-occipital region, is a large hole, the nature of

which we shall discuss later. The occipital views shown in Figs. 201, 207, and Pl. XXI make manifest the amount of distortion with which we have to contend. The masto-occipital region on the right side has been pressed inwards and upwards and the whole of the right side, the side on which the skull rested *in situ*, has become flattened. The corresponding left region has been displaced outwards, part of this being due to the extensive injury which this part of the skull has sustained.

The view of the vertex (Fig. 206) is instructive. There are three main defective areas: (1) the frontal, which involves the left half of the bone and part of the right side as well; (2) the right fronto-parietal region; (3) the left parieto-occipital region, the site of an injury. Notwithstanding these defects it is possible, by duplicating right and left sides, to gain a complete outline of the vertex. The result is a long oval skull ending anteriorly in a projecting and powerful supra-orbital torus. Indeed, although devoid of the exaggerated posterior width, the outline has a Neanderthaloid form.

The frontal view of the skull in Figs. 204, 205, and in Pl. XXI will indicate the preserved portions of the face. The roof and inner wall of the right orbit are complete and the parts of the right maxilla are in articulation with each other and with the right frontal fragment, preserving a considerable portion of the right side of the face. There are also fragments of the left maxilla and parts of both borders of the nasal aperture. The palate and teeth have disappeared and so have the greater parts of both malars. The right frontal fragment has been detached from the rest of the skull by a fracture which crosses anterior to the coronal suture (Fig. 200 x'). Unfortunately this fracture has been caused by a crushing force so that, while there is contact, there is no articulation or exact adjustment. Hence we are faced with two problems: (1) the exact level of the torus supra-orbitalis; (2) what was the width of the inter-orbital parts. In our first assay, we made the skull as short as was compatible with the general contour of the vault. The length was made 206 mm. and it is this reconstruction which is shown in Figs. 202–7. When, however, we came to fill in the parts of the face we found that the space for the upper jaw was too cramped. The face was bent backwards under the base of the skull so that the facial angle was 15° more than a right-angle. To provide accommodation for the palate, one even less in size than that of Skhūl IV and of Skhūl V, we had to raise the anterior end of the frontal fragment until the length was increased from 206 to 211 mm. To the latter we have added 2 mm. to represent the missing glabellar projection. A length of 213 mm. is the minimum which will provide space for the facial and basal parts.

Having determined the proper angle of elevation for the frontal fragment, we had then to determine its relationship to the mid-sagittal plane, for no point actually reached the mid-plane. The position which we believe to be the correct one is shown in Fig. 204. When we approached the midline to give a reasonable width to the inter-orbital process and the nasal aperture, we encroached on the space needed to accommodate nasal bones of very moderate width. The transverse diameter of the inter-orbital process is given the great width of 35 mm. (bi-lachrymal diameter) and the nasal aperture is 30 mm. wide. The width of the bridge of the nose formed by the nasal bones is only 13 mm. Furthermore, it will be seen in Fig. 204 that the space provided for the nasal bones becomes narrower as it descends, the opposite of what should be the case in a normal skull. We suspect that this anomalous relationship is due to a mal-articulation of the maxillary fragment with the frontal, but, although such an error is probable, it is not apparent in

the specimen. Also, there is no doubt that there is great variation in nasal conformation among the Mount Carmel people.

Sutures.

The coronal suture is obliterated save for three traces, at the bregma, near the pterion, and at a 'stephanion' marking in the temporal lines. The position given to the suture in Fig. 200 is based on these three traces. The sagittal suture (Fig. 205) is just traceable from bregma to lambda, save for a short segment at the obelion. The suture is relatively simple and shows the four divisions found in modern skulls. The lambdoid suture is open; its form and degree of elaboration are depicted in Figs. 201, 207. The masto-occipital suture can also be traced and the parieto-mastoid and parieto-squamous can be readily followed although filled with stalagmitic material. The squamous suture at its highest point is undergoing ossification. The condition of the sutures indicates a man of about 50 years of age, perhaps rather more.

Condition of the bone.

The bone of this skull differs in three respects from that of the other skulls from the same cave. It is of a tan-brown colour where the others are mainly straw yellow. Freshly fractured surfaces present a flint-like or vitreous structure and the bone is both more dense and much harder than in the others. The old broken edges have assumed strange shapes as though the bone might have been soft enough at one time to have been moulded by the surrounding pressures. In general, we may say that in its state of fossilization it resembles the bones from the Tabūn cave, although the character of the respective deposits was entirely unlike (Garrod and Bate, 1937).

Skhūl IX is most variable in the thickness of its cranial wall. The lower part of the frontal just above the torus is 6·2 mm. in thickness, while above the site of the frontal eminence it increases to 9 mm. and then to 11 mm. The parietal varies from 5·5 mm. just above the squamous margin to 11 mm. at the parietal bosses and near the sagittal suture. The occipital bone over the site of the left occipital pole is 5·5 mm., in the mid-line 13 mm., and at the internal inion 15 mm. The plate of the squama has a thickness of 5 mm. while the frontal, over the third convolution, is only 4 mm. thick. The thickness at the glabella we estimate to have been 20 mm.

Chief Dimensions.

These have been mentioned in the opening paragraph of this section. It is now necessary to consider them in detail. In the length measurements (Table LXXIII, p. 295) the high figure reached by the intracranial length will be noted. This measurement was made directly on the skull. Thus, of the total length (213 mm.), 187 mm. represents brain space, 26 mm. bone. Bone forms 12 per cent. of the total length, 4 per cent. more than is usual in modern skulls. In order to calculate the capacity of this cranium from the length, width, and auricular height by means of the formula already cited (p. 233), it is necessary to reduce the length to 204 mm. and the auricular height to 114 mm. The application of Pearson's inter-racial formula in this case gives us an estimated capacity of 1,587 c.c.

We have seen that Skhūl IX was ultra-dolichocephalic. The cranial cavity is less

extreme in its dimensions. The internal length is 187 mm., the width 135 mm., the latter representing 72·2 per cent. of the length. We obtain almost the same ratio when we compare width of skull (145 mm.) with the ophryo-occipital length (200 mm.). The difference between the glabello-occipital and ophryo-occipital lengths (13 mm.) represents a measure of the forward projection of the supra-orbital torus.

Certain width diameters require consideration. The forehead was narrow, the width shown in Fig. 202 being 96 mm. This is almost the same minimum frontal diameter as in the Galilee skull, which has many points of resemblance to the frontal of Skhūl IX. The minimum frontal diameter in both Skhūl V and Tabūn I was under 100 mm., whereas in the European Neanderthalians this diameter is over 100 mm., save in the narrow-headed La Quina man. The minimum frontal diameter in Skhūl IX represents 66·2 per cent. of the maximum cranial width, this low figure being due to the relative narrowness of the forehead. The maximum frontal width (120 mm.) represents 82·7 per cent. of the bi-parietal width, a proportion found in Neanderthal as well as modern skulls.

The greatest width lies at the junction of the posterior two-fifths with the anterior three-fifths, this agreeing with the distribution of the width diameter found in Neanthropic skulls. The greatest width lies in the region of the parietal eminences. These are definitely demarcated, a Neanthropic feature. The amount of irremedial distortion at the hinder end of the skull of Skhūl IX is brought out in the occipital view given in Fig. 201. The amount of inward deflexion of the right parietal is rather more than counterbalanced by the outward bulge of the left parietal in its lower part. The original bi-parietal width must have been about 145 mm., certainly not less. The skull has the same occipital contour as Skhūl IV, the sides flattened, the roof low and moderately arched from side to side. Farther forwards in the region of the bregma the transverse arching is more marked.

The lambdoid suture forms a wide and high arch (Figs. 201, 207). As in modern skulls, the sutural arch is supported by a right and left lateral limb which descend sharply to the asteria. The bi-asterionic width was apparently small, about 120 mm., but the mastoid processes, although shallow, were apparently wide apart, the width at their bases being approximately 136 mm.

The occipital bony ridges which mark the upper limit of the musculature of the neck show the transitional form which we described in the case of Skhūl IV. They form a raised rounded elevation as they skirt the impression for the complexus muscle, and as they approach the inion they form a V-shaped elevation, the apex of the V forming a median elevation on the nuchal surface between the impressions for the complexus muscles (Fig. 201, *i*). There is an incipient external occipital protuberance. Some distance above the site of the inion there is a shallow, ill-defined excavation which represents the supra-inial fossa seen in typical Neanderthal skulls and in Tabūn I.

The occipito-mastoid region has been less distorted on the right than on the left side (Fig. 201). The greater obliquity of the right nuchal ridge is due to the occipito-mastoid having been compressed and carried upwards a few millimetres. In reconstructing the profile of the skull seen in Fig. 200, the contour of the occipital lines and the muscular impressions of the nuchal region were borrowed from the right side, hence the lateral part of the occipital ridge shown in that figure is placed a little higher on the skull than

was originally the case. On the other hand, the position of the inion remains unaltered and it lies high (16 mm.) above the Frankfort plane (Figs. 200, 201, 202, 203).

The Parieto-Occipital Injury.

The large hole which exists in the left side of this skull is shown in Fig. 201, and its outline is indicated by a broken line in Fig. 200. It is an extensive opening, measuring 75 mm. from before backwards and 55 mm. from above downwards. The edges are smooth, the anterior one being bent inwards and crumpled into folds. The posterior edge is bevelled outwards. Fractures radiate into the skull from the site of injury. The force of the blow which produced the injury had shivered the parts at the lower margin of the opening and bent them outwards (Fig. 201, *o*). The fragments have not become detached from the skull but are united by stalagmite at the sites which they occupied at the time of the injury. The state of the edges of this injury precludes the possibility of the damage having been done after the skull had lost its animal matter. The injury must have occurred before fossilization had set in. The hole appears to have been produced by a perforating instrument entering the skull obliquely below the left parietal eminence and emerging to the left of the occiput at the root of the neck. If the injury occurred during life or before the flesh had perished, the muscles and tissues would have held the lower occipital fragments *in situ* until they became fixed by the infiltration of lime carbonate.

The wound found in the left hip-joint of Skhūl IX cannot be mistaken, nor explained, save as a spear wound. It is otherwise with this injury to the skull. The left side of the skull with this gaping hole lay uppermost in the deposit and the post-mortem disturbance of the burial is attested both by the fact that so few parts of the skeleton were found and by the presence of a bovid skull with the human remains (Garrod and Bate, 1937, Chapter VII, Pl. LIII, 2). We are dealing with a matter of probability as regards this skull injury; all we can assert is that the perforation *may* be of the nature of a wound.

Height of Vault.

The position of the left external auditory meatus is indicated in Fig. 200, *c*. The highest point of the vault, which is 36 mm. behind the bregma, rises 116 mm. above the Frankfort plane. No part of the base is preserved, but it is convenient to adopt a conventional basion in order that certain provisional measurements may be made. This is shown in Fig. 200, where it is placed 15 mm. below the porion on the mid-auricular plane. From such a basion the bregma is 130 mm. distant, an approximate measure of the total height of the cranium. The total vertical height, measured on the occipital aspect of the skull (Fig. 201), is 135 mm. If we take the latter as our measurement, then the height in Skhūl IX is equal to 93 per cent. of the width, a higher proportion than is usually found in Neanderthal skulls and higher than in either Skhūl IV or Skhūl V. The basi-bregmatic height is 84 per cent. of the width in La Chapelle. It seems probable that the estimate from the arbitrary basion gives a more accurate result (89·6 per cent.).

The application of Schwalbe's method of determining the height of the vault, employing the glabello-inion line as a base for measurement, gives interesting results in this instance. The glabello-inial base is very long, 212 mm., the highest point of the vault rises 87 mm. above the plane and the resulting index is 41. This is approximately the

same ratio as in the typical Neanderthal skulls of Europe. If Schwalbe's method is taken as a measure of brain development or as an indication of a stage in cerebral evolution, then it is misleading. It is really a measure of the extent to which the occipital torus has spread up the occipital bone before the expanding muscles of the neck. This is well illustrated in the present case. The internal inion, the point of confluence of the venous sinuses, is preserved and is indicated in Fig. 200 *i'*. The inion is seen to be 22 mm. higher up on the occipital than is the internal point. The glabella also ascends during the growth of the skull. Schwalbe's index indicates the relative vertical position of the glabella and inion and in this respect a low calottal index is a mark of a primitive, and a high index of an advanced, condition. Skhūl IX, in this sense, shows a primitive feature which prevails in all skulls of the European Neanderthal type.

Arcs and Chords of the Vault.

The measurements of these are given in Table LXXVI (p. 296). Many made on Skhūl IX are of a provisional nature. The post-auricular part of the skull is of great length (98·5 mm.). There is the same tendency as in Skhūl IV and V to mass the brain above and behind the ear; in Skhūl IX chiefly behind. The occiput in Skhūl IX has not the bun shape which characterizes the Neanderthal skulls of Europe, and in its profile it is reminiscent of a type found among male Australians (Fig. 200). The lambda is high (76 mm.) above the Frankfort plane and far forwards (16 mm. in front of the opisthocranion), as is usual in Neanderthal skulls. The part of the occipital which surrounds the foramen magnum is missing, but from the portions preserved it is possible to estimate the position of the opisthion. It was about 66 mm. from the inion, giving a total measurement of arch for the occipital of 129 mm., a very high amount. The chord we estimate to have been 95 mm., the subtense 36 mm., the latter representing 37·8 per cent. of the chord. This ratio in the Gibraltar skull is 38 per cent., in La Chapelle, 37·2 per cent., and in a low and long Australian skull 27·7 per cent. Skhūl IX falls into the Neanderthal group in the degree of curvature of the occipital bone.

The frontal angle measured on the reconstruction shown in Fig. 200 is 67°, 4–5° more than in Skhūl IV and V. The frontal arc of the reconstruction measures 130 mm. and has a chord of 114 mm. The total sagittal arc we estimate to have been about 379 mm., 24 mm. less than in Skhūl IV. The circumference of the right half of the skull measured above the torus is *c.* 280 mm.

Temporal Region.

The squama of the temporal is complete on the left side and presents many points of resemblance to the same element in the La Chapelle skull. A close inspection shows that 3 mm. of the posterior margin of the great wing of the sphenoid still adheres to the temporal, the sutural line, which is remarkably straight, being just traceable. The suture is imbricated as in the Galilee skull and apparently closed. The length of the squama from the parietal notch behind to the most forward part of the sphenoid margin measures 70 mm., against 73 mm. in La Chapelle. In Skhūl IX the spheno-temporal suture lies 43 mm. in front of the mid-auricular plane. The projection in La Chapelle is 40 mm., in Skhūl IV, 38 mm., in Gibraltar, 33 mm., and in the large male Predmost skull, 44 mm. The upper border of the squama in La Chapelle has a very low arch and this is also the

case in Skhūl IX, but in La Chapelle it rises only 42 mm. above the Frankfort plane, while in Skhūl IX the elevation is 48 mm. The height in Skhūl IX is 67 per cent. of the total length of the squama; in La Chapelle it is only 58·8 per cent. The ratio is 68·5 per cent. and the height 50 mm. in the large Cromagnon skull from the Grottes des Enfants. Thus in the squamous part of the temporal of Skhūl IX we appear to have an element which is transitional between the Neanderthal and the modern type.

It will be noted that in filling in the blank between the squama and the orbit in Skhūl IX (Fig. 200) we have had to introduce the wide-winged sphenoid of the Neanderthal and the Skhūl form.

The temporal lines occupy what we may call a 'normal' position. Using the method already described (p. 245), the temporal line is found to occupy a position 85 mm. above the Frankfort plane, the total length of the arc to the sagittal suture being 153 mm.

Nuchal Region.

The area of attachment of the neck to the skull is shown in profile in Fig. 200 and from behind in Fig. 201; measurements are given in Table LXXXII (p. 298). The great post-auricular development has already been noted. The inion lies 98·5 mm. behind the mid-auricular plane, 9 mm. more than in the La Chapelle skull and 16 mm. more than in the skull of the Old Man of Cromagnon. As in the two other Skhūl men, the neck was of great thickness from back to front. Measured along our nuchal plane (Fig. 176) the antero-posterior diameter of the area of fixation is 95 mm., a record for a human skull, and an indication of great strength. The width of the neck, measured between the bases of the mastoid processes, was at least 136 mm. The area for the insertion of the complexus has the same extent and obliquity as in Skhūl V.

The whole of the mastoid process is missing on the right side, but its posterior part is preserved on the left. So is the posterior part of the digastric fossa. The mastoid must have been similar in size and form to that preserved in Skhūl IV. The paramastoid eminence was not prominent. In both the Tabūn and the Gibraltar skulls this eminence is greatly developed.

The Face.

The anterior aspect of the face is shown in Fig. 204. From this it will be apparent how much of the face is preserved and we have already explained (p. 278) our difficulties in giving a satisfactory orientation to the parts connected with the nose. The glabellar region and the whole of the left supra-orbital torus are missing, but sufficient of the right torus remains to leave us in no doubt as to the characters of the whole. The resemblances to the Galilee frontal are numerous and close. The whole of the right torus is preserved save in its medial part, of which we estimate that 15 mm. is lacking to carry it to the midline. The actual width of the part preserved is 53 mm. (oblique), but the projected width (at right-angles to the sagittal plane) is 47 mm. The total width of the supra-orbital torus we estimate to have been 124 mm. ($47+15 = 62\times 2 = 124$). This is 5 mm. more than in the Galilee skull and the same width as in La Chapelle.

One can recognize in the torus of Skhūl IX, as in the Galilee skull, a division into two parts, a medial (supraciliary) and a lateral (supra-orbital) element, the former being much the thicker in a vertical direction. There is a flattening of the upper surface of the

lateral element in its middle part, with a thickening at the external angular process. The forward projection of the torus is the same as in the Galilee frontal, 13 mm. in its supraciliary part. The vertical measurement of the torus in the supraciliary part gives a height, from the roof of the orbit, of 16·2 mm.; in Galilee it is 16·5. A vertical measurement made near the middle of the lateral segment of the torus gives a thickness of 10·2 mm.; in Galilee, 11·5 mm. The curvature of the torus will be seen from the drawings in Figs. 204, 205, 206 and from Pl. XXI. The lateral end dips downwards to meet the orbital process of the malar.

Frontal Sinus.

The broken surface of the supra-orbital torus (Fig. 203) exposes the right lateral sinus, lying within and confined to the supraciliary segment of the torus. The posterior wall has been crushed in, diminishing the antero-posterior diameter of the sinus; originally it must have measured 10 mm. and its height at the point of section is 18 mm. The thickness (vertical diameter) of the torus at the point of fracture was originally about 16 mm. The sinus seems to us remarkably small for so large a skull.

Supra-orbital Torus.

There are three relationships of the supra-orbital torus that require mention. The first is its relationship to the minimum frontal width, which it exceeds by 28 mm., an excess which we regard as indicative of large temporal muscles. Secondly, there is its relation to the orbital width; the distance between the medial ends of the fronto-malar sutures is 108 mm. The supra-orbital width exceeds this bi-orbital measurement by 16 mm. The third relationship is to the inter-orbital process. We have had to give the inter-orbital septum a width of 35 mm. in Fig. 204, to allow sufficient nasal space. Such a width is without parallel among fossil skulls. The nearest comparison is found in the Rhodesian skull with an inter-orbital width of 34·5 mm., and exceptional Negro skulls reach 36 mm. The bi-dacral width in Skhūl IX is 30 mm., the bi-lachrymal, 35 mm. The inter-orbital width represents 32·4 per cent. of the inner bi-orbital width. In modern peoples the means for the inter-orbital index vary between 18 and 22, but the bi-orbital width component is that taken between the ektoconchia, a measurement which is usually a little shorter than the one we have had to use. This emphasizes rather than diminishes the great difference in these orbito-facial relationships between the Palestinians and modern peoples.

There is enough of the inter-orbital process remaining to indicate the conformation of the parts. They were very similar to the glabellar region in the Galilee skull. The union of the root of the nose with the forehead was saddle-shaped.

Orbit.

The diameters of the right orbit can be estimated, and they are in no wise remarkable. The width was about 44 mm. and the height was 37 mm., the latter representing 84 per cent. of the former and placing the index in the meso-conch group. The most remarkable circumstance connected with the orbit is the preservation of the medial wall with the complete lachrymal bone and the complete fossa for the lachrymal sac and nasal duct. A notable feature of the fossa is its height; from the margin of the orbit (at the opening of the nasal duct) to the upper border of the lachrymal groove it measures 16·5 mm. The antero-posterior diameter of the lachrymal groove is 8 mm. In the upper medial quadrant

of the orbit is a deep groove for the trochlearis tendon with a sharp tubercle lying just in front of it. The lower margin of the orbit in its medial half is ridge-like and narrow, not wide and rounded as in Skhūl IV.

The Nose.

Remarkable features of the face of Skhūl IX are found in connexion with the nose. These peculiarities do not concern the problem of reconstruction but the interpretation of structures actually preserved. We have parts of both right and left margins of the nasal opening (Fig. 204). The margins are not rounded but are sharp and thin. The condition is reminiscent of what we may observe in modern people who suffer from contraction of the palate. In such modern skulls we find the lateral and lower margins of the pyriform aperture raised to form a knife-like edge. The lateral margins of the nasal openings in Skhūl IX are sickle-shaped and have sickle-like edges, a condition somewhat similar to that seen in the Gibraltar nose. The latter has double entrance pillars or thresholds, an inner and an outer, separated by a depression or groove. The outer margin is sharp and extends from the lateral margin to the nasal spine. In Skhūl IX, outer and inner thresholds appear to be conjoined so as to form a single sharp ridge. The medial part which carries the nasal spine is missing, but we suspect that its form must have been similar to that found in the Gibraltar skull. Our estimates give a height of 55 mm. to the nose of Skhūl IX and a width of 30 mm., the latter being 54·5 per cent. of the former. This is a wide nose. The nasal aperture of the Gibraltar skull is both higher (58·5 mm.) and wider (34·5 mm.).

The ascending process of the maxilla takes a large part in the formation of the external nose. This process in shape and size is not unlike that of the Tabūn woman. It has not the ample dimensions of the Gibraltar process. The width of the nasal part, measured from the margin of the orbit at the lower end of the lachrymal groove to the most distant point of the nasal margin, is 18 mm.; in the Gibraltar skull this measurement is 22 mm., and in the Tabūn woman it is about 20 mm.

There are numerous points concerning the nasal conformation of Skhūl IX which must remain unanswered. We are certain, however, that it was not big and prominent as in Skhūl IV. Indeed, the evidence as far as it may guide us points to a flat nose, rather Negroid in character. On the other hand, its sharp lower margin is a feature which has hitherto been regarded as one of late development in the evolution of the human family.

The Face in Profile.

In spite of the defective nature of the face, the features of the parts preserved are remarkable and urge us to ascertain all that can be inferred from them. It is possible to make an approximate measurement of the upper facial angle from the profile view in Fig. 200. The two points required are the nasion and the prosthion, the site of the former being clearly indicated by the markings on the preserved part of the inter-orbital process. There is no alveolar arch but with such a lower nasal margin there is never associated—so far as our experience goes—subnasal prognathism. We have filled in the missing upper alveolar parts accordingly. This reconstruction gives a facial angle of 93°, a degree of hyper-orthognathism not unlike that found in Tabūn I and Skhūl IV. Skhūl V, it will be remembered, is prognathous (Table LXXVII, p. 297). In our

original reconstruction of Skhūl IX (p. 278) the facial angle measured 105°. We may test our reconstruction (Fig. 200) in another way. The length of the basi-cranial axis is shown there as 115 mm., which is 8 mm. less than in La Chapelle but 5 mm. more than in Skhūl IV. The basi-alveolar distance is 106 mm., 19 mm. less than in La Chapelle but about equal in amount to our estimate for Skhūl IV. We have confirmatory evidence in this of the retraction of the face backwards under the basi-cranial axis as in Tabūn I and Skhūl IV, but not as in Skhūl V, where the prognathism is pronounced. The length of the upper face shown in the reconstruction is 74 mm. This is probably an under-estimate; we are dealing with a long-faced people.

The projection of the glabella (Table LXXIX, p. 297) in front of the mid-auricular plane is 113 mm., the same as in La Chapelle and slightly more than in Skhūl IV. The projection of the nasion (107 mm.) is almost the same as in La Chapelle, and the projection of the lateral wall of the orbit is again almost the same. There was about the same degree of angulation of the upper face. But when we come to compare the projection of the ascending process of the maxilla in these two, Skhūl IX and La Chapelle, there is a decided difference. The projection in the French skull is 118 mm., almost the same as in Skhūl IV, but it is only 107 mm. in Skhūl IX. Manifestly the nose in the latter specimen was flatter and less prominent than in the other two skulls chosen for comparison.

The projection of the lateral margin of the nose in Skhūl IX is further evidence of the orthognathous conformation of the face. The projection is 99 mm., whereas in La Chapelle it is 108 mm., in Tabūn I, 92 mm., and in Skhūl IV, 97 mm. Skhūl IX, in his nasal conformation, must have had many points of resemblance to Skhūl IV.

The skull of Skhūl IX, although less complete in its preservation than the three described previously, is yet in several respects the most remarkable of the group. We may summarize its characters thus: it had extraordinary dimensions; its length was very great (213 mm.) and the width was moderate with the vault relatively low. The cephalic index was 68, extremely dolichocephalic. Like all the other Palestinians, the width was great compared to the height, and in this instance the post-auricular length was extreme. In its dimensions and in some points of conformation Skhūl IX shows resemblances to the La Chapelle skull, although the cranial capacity, 1,587 c.c., is somewhat less than the capacity assigned to that famous specimen (1,626 c.c.). In Skhūl IV we found Neanthropic features predominating over the Palaeoanthropic ones; here it is the opposite. The squama temporalis agrees with that of La Chapelle in shape and very nearly in size, being somewhat the higher.

The supra-orbital torus of Skhūl IX is wide (124 mm.) and greatly developed, having its closest resemblance to the form seen in the Galilee frontal. Apparently the region of the glabella and the nasion was modelled much as in that specimen. The inter-orbital process was very wide (35 mm.) and so was the nasal opening (30 mm.). The nose, in the conformation of its lower and lateral margin, differs from all fossil skulls found hitherto in the sharpness of its nasal sill. The only ancient skull which at all resembles it in this respect is that of the Gibraltar woman.

The face was not prognathous but the opposite, being bent backwards under the base of the skull, with an upper facial angle of *c.* 93°. In this feature Skhūl IX resembles two of the other ancient Palestinians, Tabūn I and Skhūl IV.

SKHŪL II (Figs. 208, 209)

Male skulls have generally fared better than female in the Skhūl cave. The three male specimens we have described have been reasonably complete but the two female examples of which we will now give an account are very fragmentary. So, too, is another male skull, Skhūl VI. The imperfect preservation of the women's skulls and skeletons is the more to be regretted when it is remembered how ill informed we are concerning the differences due to sex among the Neanderthal people of Europe. To throw light into this dark corner, we have used every item of evidence presented by the cranial fragments from the Skhūl cave, which are undoubtedly those of women. We are convinced that mistakes have been made with regard to some of the European Neanderthalians, particularly the adult skull from La Quina, which the late Dr. Henri Martin regarded as belonging to a woman. Its characters are those of a narrow-headed male. The same is true of the Galilee frontal bone, which one of us was inclined to regard as female; it, too, is undoubtedly male, as Dr. Hrdlička has suspected (Hrdlička, 1930).

The parts of Skhūl II are enumerated in Chapter I. The right humerus is of the most importance, a long and slender bone of which about two-thirds is preserved. Its original length we have estimated to have been 330 mm. giving a stature of about 1,625 mm. (5 ft. 4 in.). There are three chief fragments of the skull of considerable size. The first and most important of these we shall discuss presently. It consists of about two-thirds of the supra-orbital torus with the inter-orbital process and the site of the attachment of the nose (Fig. 208).

The second fragment is composed of a V-shaped portion of the occipital carrying the right and left limbs of the lambdoid suture. This articulates with an irregular fragment of the upper and hinder part of the right parietal. On the parietal is preserved 35 mm. of the sagittal and about 58 mm. of the lambdoid suture. There is a medium-sized parietal foramen 22 mm. above the lambda and 8 mm. distant from the sagittal suture. The pars obelica of the suture lies in a distinct depression, a wide shallow groove between the upward swelling of the parietals on either side. On the internal surface of this fragment the only feature to be noted is the clear impression, just above the internal lambda, of the sagittal sinus. The third fragment is composed of several pieces of the left parietal. The lowest margin of the fragment preserves a small part of the rugose surface for contact with the squama of the temporal. In front, on the inner surface, are traces of the channels for the anterior branch of the middle meningeal artery and veins but no part of the coronal suture remains. The fragment falls short of the mid-line by 5–7 mm. and its most posterior part extends just beyond the parietal tuberosity, which is very thick. There are, in addition, about a score of fragments of varying size none of which we were able to join to the major pieces just described. Of these we may mention two more fragments of the right parietal, a middle portion and the mastoid angle, several other fragments of parietal, and the roof and walls of the meatus of the right temporal but without the tympanic plate.

A comparison of these fragments with the corresponding parts of entire crania leaves us with the impression that the skull was of moderate size with a capacity of perhaps 1,300 c.c. The parietal eminences were moderately marked. At the eminence the bone has a thickness of 10·5 mm., but the parietal lower down, where it approaches the squamosal suture, has a thickness of only 4–5 mm. The frontal, 30 mm. above the ophryon,

has the same thickness, 4–5 mm. This skull, as was also the case with Skhūl IX, shows an exceeding degree of variation in the thickness of its walls. It varies from 4 to 11 mm. in the vault, but the mean tends to lie between 6 and 8 mm.

The sutures are simple in character and from the portions preserved all appear to have been open with the possible exception of the sagittal suture in the region of the obelion. The teeth, on the other hand, are worn, the incisors as much as half-way down the crowns. We estimate this woman's age as being probably under forty years.

There are two important fragments of the face, the symphysial part of the mandible (Chapter XIV, and Fig. 153) and the greater part of the supra-orbital torus (Figs. 208, 209). The mandibular fragment presents two important characters: (1) it is slender and shallow; (2) it has a well-developed chin or mental eminence. There cannot be any question that it belongs to a woman. With such a mandible, one was scarcely prepared to find a well-developed supra-orbital torus in the same face.

The supra-orbital torus of Skhūl II extends on the right side to, or almost to, the medial end of the fronto-malar suture, while on the left side it extends only 25 mm. beyond the mid-line (Fig. 208 B). Its lateral projection on the right side is 53 mm. from the mid-line. We believe that only about 5 mm. is missing, so that the original width must have been about 116 mm., perhaps more, certainly not less. Its width would thus be about the same as that of the Galilee frontal (Fig. 208 A). Probably the minimum frontal width was also similar, 97 mm. The medial (supraciliary) and the lateral (supra-orbital) elements are separated, as they are in the Galilee specimen, by an oblique groove which begins at the supra-orbital notch and passes upwards and outwards. The medial element is elevated, rounded, and high, while the lateral is flattened on its upper aspect.

It is difficult to give satisfactory measurements of the projection (a-p. diameters) of the torus. To the eye the brow-ridges of the Galilee man seem more massive and powerful than those of this woman. It will be recalled that the glabella and the medial element of the torus project 13 mm. in front of the ophryon in Skhūl IX, when the cranium is placed in the Frankfort plane. The projection is the same amount in the Galilee frontal, but in this woman, when the frontal is placed at a corresponding angle, the projection is only 9 mm.

More difficult still is the comparison of the vertical heights or thickness of the medial and lateral elements of the torus. The measurements we have made were taken at two points, at the middle of the medial and at the middle of the lateral segments of the torus, from the roof of the orbit to the overlying surface. The torus diminishes in height as it approaches the free supra-orbital border, so that it is necessary to take the measurements at a fixed distance behind the free border. This point was fixed at 10 mm. behind the free border in male skulls and at a corresponding distance, 6 mm., in female skulls. The height of the medial element in Skhūl II was 15 mm., in Galilee 16·5 mm., and 17 mm. in Skhūl IX. As regards the height of the lateral element, Skhūl IX is lowest with 9·5 mm., while it reaches 11 mm. in both Skhūl II and Galilee. Thus in thickness there is not a great sexual difference in the development of the torus, but it is otherwise in the amount of forward projection; the males exceeding the females by 3 mm. or more. Even in the case of Skhūl II, where the height of the lateral element exceeds that of Skhūl IX, in the matter of projection her lateral toral element falls 5·5 mm. short of that of the male.

A sagittal section of the glabellar region of Skhūl II is shown in Fig. 208 B′, where it is compared with a corresponding section of the Galilee frontal (Fig. 208 A′). The thickness of the bone at the glabella, measured to the nearest point of the endocranial surface but avoiding the frontal crest, is 17 mm. in the Galilee specimen (slightly more in Skhūl IX) but is only 14 mm. in Skhūl II. The internal frontal crest is shallower in Skhūl II (5 mm.) than it is in the Galilee bone (8 mm.), but their attached bases are equally wide.

The differences in strength and in shape between the Galilee glabellar region and that of Skhūl II are probably not due entirely to sex. They may also indicate a racial differentiation. The glabella is high above the nasion in the Galilee frontal; in Skhūl II, as in Skhūl V, the infra-glabellar region has become shortened and strongly convex forward. There must have been a notch at the junction of the nose and forehead similar to the one that is so marked a feature of Skhūl V.

The width of the inter-orbital process (bi-lachrymal) is 28 mm. in Skhūl II, the same as in the Galilee frontal. The inner bi-orbital width (between the medial ends of the fronto-malar sutures) is 109 mm. in Galilee and probably it was 5 mm. less in Skhūl II.

The facets for the frontal ends of the nasal bones and those for the other constituents of the bony nose are well preserved in the frontal fragment of Skhūl II (Fig. 208 B). The nasal bones at their upper ends were very flat and had a combined width of 13 mm. The nose at its root must have been Australoid or Negroid in appearance. The naso-frontal articulation was certainly very different from that of the Gibraltar woman.

The characters of the nose of Skhūl II are also brought out by the drawings given in Fig. 209, where the lower surface of the Galilee frontal is compared with that of the Skhūl fragment. The more robust development of the Galilee bone is made manifest in these drawings. Another important distinction is that in both Galilee and Skhūl V the frontal sinuses reach a moderate development, but in Skhūl II the right frontal sinus is undeveloped and the left is a mere rudiment, lying below the level of the nasion.

Another instructive fragment of Skhūl II is shown in Fig. 209 D. It is that part of the right temporal bone which forms the outer part of the auditory meatus. The tympanic plate has dropped from the meatus, leaving the impression of its attachments. We have filled in a hypothetical section of the tympanic plate in Fig. 209 D, following the suggestions given by the markings in the meatus. It is clear that the plate could not have been of the wide, flat Neanderthal type, seen in the Gibraltar skull (Fig. 209 C). The post-glenoid spine is present in Skhūl II; its anterior surface is steep whereas in the Gibraltar skull it is almost horizontal. It is clear that the lower jaw articulated with the skull by a joint which was modern and deep as in Skhūl IV and V. The plate of bone (Fig. 209 D, x) which forms the roof of the fossa was very thin in Skhūl II.

Thus, as far as we can learn from her fossil remains, this Skhūl woman (No. II) showed resemblances not to the Tabūn or Galilee people but to her own people, especially to the form represented by the male, Skhūl IV.

SKHŪL VII (Figs. 210–11)

The limb bones of this individual indicate that the stature was about 5 ft. 2 in. (1,580 mm.), and their conformation and size are female in character. The forearm bones have the ample curvature of the Neanderthal type, but are slender in their build, as are those of Tabūn I. The limb bones show a blend of Neanthropic and Palaeo-

anthropic traits and the skull, too, possesses the same combination of traits, as far as its features may now be deciphered.

The skull is much crushed and compressed and there are extensive areas which are lacking. A reconstruction is impossible, but the mosaic of fragments has been exposed and left embedded in a slab of breccia. From this it has been possible to discover many of the original characters of the skull.

The drawing, Fig. 210, shows the parts exposed on one face of the block of breccia. They are those of the right frontal region and of the right side of the face. Above the compressed right orbit (*a*) is the outer end of the right supra-orbital torus (*exp*). Its conformation is that found in Neanderthal skulls. The lateral part of the torus is rounded and thick with a vertical height of 12 mm. This, about the same thickness as in the Tabūn woman, is 1 mm. greater than in Skhūl II and from 1·8 to 0·5 mm. more than in Skhūl IX and Galilee respectively. Indeed, the skull of Skhūl VII is robust and had one found only the torus it might have been quite reasonably assigned to a male.

The outer end of the torus is not only thick but laterally protuberant. With the frontal in its natural position the external angular process extends 13 mm. beyond the temporal ridge. The supra-orbital width must have been 26 mm. greater than the minimum frontal width. The torus was also forwardly protuberant, for its anterior edge lies 24 mm. in front of that point on the temporal line which marks the site of the minimum frontal measurement. The forward projection is as great as in Skhūl IX. In Skhūl VII, then, the supra-orbital torus was masculine in its strength, and yet we cannot doubt that the individual was a female.

Malar (*Os Zygomaticum*)

We are convinced that the region of the cheek affords a clue to race better than most parts of the skull, and it is a regret for us that the Mount Carmel series has not provided one perfect specimen from this region. We have nearly all the parts of the malar in Skhūl VII, but as will be seen from the drawing, Fig. 210, it has been broken into eight fragments by a backward compression which has forced the malar upwards against the right temporal region. Nevertheless, it is possible from an inspection of these parts to obtain a perfect picture of the original character of the bone. Unlike the Neanderthal and the Galilee malar, which has a long, straight, and not particularly robust orbital process, Skhūl VII exhibits a process of great strength. Its antero-posterior diameter, measured between the orbital and temporal borders at the mid-point of the orbital wall, was not less than 17 mm., as against 13·8 mm. in the Gibraltar malar. The orbital margin of the Galilee malar is sharp and its lateral surface is flat, whereas in Skhūl VII the orbital margin is blunt and its lateral surface convex. The difference in strength is particularly well seen at the upper end of the orbital process, just below the fronto-malar suture. The posterior border, which at this point on the Galilee bone is ridged, is only about 5 mm. wide, whereas in Skhūl VII the posterior border, which is convex and rounded, is twice the width and strength of the Galilee malar. The great strength of the Skhūl malar interests us because we believe that it represents a strengthening of the lateral malar pillar, seen in Neanthropic crania. The stresses which are transmitted to the upper jaw during mastication are distributed to the vault of the skull by three bony pillars, a median one, represented by the inter-orbital process with a double base in the form of the

ascending processes of the maxilla, and the two lateral supports, represented by the right and left malar pillars. In Palaeoanthropic crania the inter-orbital pillar is very solid and of great strength while the lateral pillars are weaker. In Neanthropic crania it is the reverse. Skhūl VII seems to show an early stage of the strengthening of the lateral pillars.

The facial part of the body of the malar is plate-like and relatively small in the Galilee malar, as it is in the Gibraltar specimen. In Neanthropic crania the body becomes large and convex. The body of the malar has assumed Neanthropic characters in Skhūl VII, which we found also to be the case in Skhūl IV. A tuberosity of the fragment marked (*g*), Fig. 210, marks the anterior limit of the masseteric origin. The horizontal process which passes backwards to form the zygomatic arch is strong although its height, measured at the malar angle from the masseteric to the temporal border, is only 13 mm., the same as in the Galilee specimen. The corresponding diameter in a modern Australian is 17 mm.; in this we appear to have a Neanderthal character.

In the block of breccia below the orbit can be distinguished the lateral wall of the maxillary sinus (Fig. 210 *f*). It is large and similar in shape to that seen in the Galilee face.

In its present state the height of the right orbit measures 27 mm.; it probably measured about 10 mm. more in the intact state, the lower margin of the orbit and the body of the malar having been pressed upwards and backwards by that amount.

There are several points which deserve mention before we leave our consideration of Fig. 210. The ridge for the attachment of the right temporal muscle to the frontal bone is strong, raised, and clearly marked. The coronal suture between the frontal (*fron*) and the parietal (*p*) is represented by a linear depression filled with breccia. This suture is similarly indicated on the left side (Fig. 211 s, s^1), from which we infer that the coronal suture was not united at the time of death. The teeth, on the other hand, are much worn, so that the dentine is exposed on the whole of the occlusal surface of the first molar. The crowns of the upper incisors are worn, about one-third of them having been chewed away (Chapter XIII and Fig. 140 A, B).

At this point, too, it is convenient to note the thickness of the bones of the cranial vault. We found a great variation in thickness in the woman, Skhūl II. Here the thickness is more uniform, varying from 5 to 7 mm. in the parietals and the frontal. The open state of the sutures and the degree of wear of the teeth indicate that Skhūl VII was probably under forty years of age at the time of death.

In Fig. 210 we have included the half of the mandible which lay at the point shown. The ascending ramus is crushed and the hinder part is lacking, but the situation and size of the fragments leave no doubt that the ramus was a high one. In its present condition from the lower border to the apex of the sharp-pointed coronoid process it measures 71 mm. The coronoid process has a very stout strengthening bar within it. The ramus was not only high but apparently descended at rather a steep angle, indications of a long face. We shall return to a consideration of the ramus in connexion with the parts seen on the left side.

The parts on the reverse side of the block—the upper surface of the skull as found *in situ*—are depicted in Fig. 211. The fold along the vault of the skull had not occurred at the sagittal suture, but to the left of it, so that we have not only the whole length of the coronal suture (Fig. 211 s–s^1) but also the site of the upper end of the right coronal (s^1–y). We believe the position of the bregma to be at or near the point marked (s^1). On

the left frontal the position of the temporal ridges is indicated (*tl*). They can also be identified as they cross the left parietal, below and in front of the parietal eminence (*pe*).

We believe that the cranial capacity of Skhūl VII was moderate in amount, perhaps in the neighbourhood of 1,400 c.cm. This inference is founded on the dimensions of the parts preserved. The coronal suture was at least 115 mm. long, from pterion to bregma, and that measurement indicates frontal and parietal bones which give a capacity about the size suggested. The right frontal between the fronto-temporale and the stephanion measured approximately 50 mm. It will be seen from Fig. 211 that the left squama is of good dimensions. Its upper border was high and curved as in Neanthropic skulls. Its highest point extends 44 mm. above the level of the upper border of the meatus. The lower part of the anterior border of the squama remains, but the parietal contact has been destroyed so that its anterior limit cannot be determined accurately. However, the length of the squama, from the anterior border to the probable site of the parietal notch, was not less than 62 mm. The height represents about 71 per cent. of this length, a Neanthropic proportion. Such a temporal indicates a vault of moderate auricular height, between 114 and 116 mm.

The zygoma (Fig. 211 *z*) was broken near its root across the anterior part of the articular eminence. The arch appears to have been of remarkable strength. The width of the root, measured from its attachment at the anterior part of the squama to the lateral border of the tuberosity at the base of the zygoma, measures 20 mm. In a male Australian the same measurement gave 14 mm., and in the Gibraltar skull, although the exact measurement is impossible, the width was certainly under 15 mm. In keeping with this is the massive size of the corresponding condyle of the mandible (Fig. 154). The latter has suffered from rheumatoid changes and its articular surface forms a rough, oblong, flat field. The condyle measures 16·7 mm. (antero-posterior) and 22 mm. from side to side. The undeformed left condyle measures $13{\cdot}4 \times 21{\cdot}2$ mm.

The temporo-mandibular region is sufficiently well preserved to make clear that the joint was Neanthropic in form. The tympanic plate is strong and thick and descends obliquely to form a posterior wall to the joint. The depth from the site of the porion to the free edge of the plate was not less than 12 mm. The post-glenoid spine in front of it was blunt and strong (Fig. 211 *b*).

What remains of the mastoid process, the digastric fossa, and the para-mastoid eminence is shown in Fig. 211 *ms*. These parts in their size and shape are similar to the same structures in Tabūn I, that is to say their form is Neanderthaloid.

Part of the floor of the glenoid fossa is preserved and shows the roughening of the surface and walls which corresponds to the rheumatoid characters of the mandibular condyle. In Skhūl V it was the opposite side which evinced these features, but the condition was the same. The anterior part of the fossa with the articular eminence is missing, but from the portions which remain it appears that cavity was rather like that of the Tabūn woman, neither the very deep form met with in Skhūl IV nor the shallow fossa which characterizes the Gibraltar skull.

Thus we see that in the characters of the temporo-mandibular region Skhūl VII was similar to the Tabūn woman. Although the malar is lacking in the latter specimen, yet in the characters of the face so far as they are preserved, this Skhūl woman appears to differ from Tabūn I, being Neanthropic. The supra-orbital torus and such features of the

vault of the skull as can be deciphered suggest further parallels to the Tabūn form; they are Palaeoanthropic. Certainly in so far as we may compare Skhūl VII with Skhūl II, the former is more suggestive of the female form met with in the Tabūn cave and yet the points of resemblance to the males from the Skhūl cave persist.

It may be thought that we have been too detailed in our description of a skull which is so imperfect. We do not think so. We shall wait a long time if we postpone our inquiry into the characters and the varieties of the mid-Pleistocene races of mankind until we have perfect specimens at our disposal. Especially was it necessary to make every effort to discover the degree of differentiation which existed between the two sexes in ancient Palestine, and Skhūl VII is one of our most important sources of information concerning this problem. Our inquiry has led us to the conclusion that in the craniological features of this woman the Palaeoanthropic characters predominated. Especially unexpected and in contrast to Skhūl II is the great development of the supra-orbital torus and the strength of all the parts connected with mastication. We are also sure that in size and shape of the brain-containing part of the skull this woman had those characters which are found in all the specimens from the Skhūl cave.

SKHŪL VI (Fig. 212)

We have come to the conclusion from a consideration of the parts of the limb bones which have been preserved, particularly from the nearly intact left femur, that Skhūl VI was a male about 5 ft. 7 in. (1,709 mm.) in stature. His masculinity is further borne out by the characters of the mastoid processes which are massive, and altogether Neanthropic in their conformation (Fig. 212 B). He was probably thirty-five years of age, or more, for even his lambdoid suture was so perfectly closed that it is hard to be certain of its position. Nevertheless, the lower left M–3, preserved in a fragment of the mandible, is only slightly worn (Fig. 152). This fragment is the only part of his face which is preserved. The minimum width of the ascending ramus was about 42 mm., indicating strong muscles of mastication.

The only large part of the cranium of Skhūl VI which has been preserved is shown in Fig. 212 B, where it is compared with the corresponding region of a male Australian. The Skhūl fragment represents only the hinder part of the skull. It has been left embedded in a flattened block of breccia of a particularly dense and resistant nature, only the external surfaces of the bones being visible. The bones of the vault have been compressed and forced downwards towards those of the base. Similarly the bones of the base, particularly in the region of the foramen magnum, have been forced upwards and inwards and form an intricate assortment in which the individual parts can be distinguished with difficulty.

The fragment is well worth description, for it throws light upon several points in the anatomy of the Skhūl people. The left auditory meatus and adjoining parts are perfectly preserved, but this region has been driven inwards so that in making the drawing shown in Fig. 212 it was necessary to rotate the fragments away from the sagittal plane, thus foreshortening the post-auricular part of the skull. As drawn in Fig. 212 the position of the inion is represented as being only 61 mm. behind the mid-auricular plane, but the actual distance, with the skull properly orientated, is about 90 mm., the same distance as in Skhūl V. Indeed, in the nuchal region, Skhūl VI presents several resemblances to

Skhūl V. There was the same deeply cut, inclined impression for the complexus muscle and the same rounded bony ridges above the impression, these ridges representing the occipital torus. The region of the inion has been eroded so that we cannot say whether or not there was an external occipital protuberance. But Skhūl VI had the same strong neck as the other Skhūl men. It is possible to measure the width of the neck, taken at the bases of the mastoid processes. At this level the bi-mastoid diameter was under 140 mm., probably 136 mm. In the Australian skull shown in Fig. 212 A, the bi-mastoid width is 123 mm., while the inion was situated about 73 mm. behind the auricular plane. It will also be observed that in the Australian skull the inion lies well below the level of the Frankfort plane, whereas in Skhūl VI it is placed far above it, as in Skhūl IX. From this it will be seen how massive and strong the neck of this man was, compared to that of the Australian.

Mastoid Process.

The left mastoid process is perfectly preserved and is joined to the neighbouring areas of the skull. In all its characters it is Neanthropic, not Palaeoanthropic. Its outer surface, which bears the rough impressions for sterno-mastoid and semi-spinalis muscles, is almost vertical in position, not sloping downwards and inwards as in Neanderthal skulls. The process is massive, the apex descending 30 mm. below our estimate of the position of the Frankfort plane. It is much more powerful than is the mastoid in the Australian skull with which we have compared it, and it exceeds the large mastoid of Skhūl V. Much more important is its relation to the digastric fossa and to the paramastoid eminence which forms the medial wall of the fossa. The apex of the mastoid descends 13 mm. below the floor of the fossa and 10 mm. below the paramastoid eminence. In the Australian the corresponding figures are 12 and 9 mm. We meet with a fully evolved Neanthropic character in this feature of Skhūl VI. The fossa, too, is a relatively narrow deep groove as in modern skulls.

Tympanic Plate.

The arrangement of parts around the auditory meatus is also Neanthropic. The root of the zygoma has been driven backwards so as to crush the post-glenoid spine (Fig. 212 B, *b*) and to compress to some extent the auditory meatus. In spite of this injury it is evident that the tympanic plate had the deeply oblique position seen in Skhūl IV and in modern people. The outer end of the tympanic plate encircles almost the entire circumference of the meatus, only a segment at the upper and hinder part being left uncovered. The outer margin of the tympanic plate, which is 4–5 mm. in thickness, is divided into anterior and posterior parts by a shallow notch situated at the anterior border of the mastoid. The anterior part of the plate is 21 mm. long and extends from the roof of the meatus behind the post-glenoid spine to the anterior border of the mastoid. The posterior part lies within the meatus and is applied to the mastoid process. The meatus is oval in form, 10·5 mm. in its vertical diameter and 6·5 mm. in its antero-posterior.

The root of the zygoma bearing the articular eminence was plate-like in shape and very wide, as it was in Skhūl VII. The supra-meatal ridge is continued backwards by the supra-mastoid crest and attained great prominence.

The mastoid part of the right temporal is also preserved. It is broken at the junction

with the tympanic plate in front and along the line of the parieto-mastoid suture. The occipito-mastoid suture evidently divided the paramastoid eminence on this side of the skull. Accompanying this fragment is the lateral angle of the occipital. It is 14 mm. thick just behind the asterion, but only 5 mm. in thickness where it approaches the middle of the area for the right cerebellar fossa. On the mastoid area there is a single mastoid foramen of moderate size. Internally the course of the lateral sinus is clearly indicated on both fragments; it seems clear that the transverse sulcus hardly, if at all, touched the mastoid angle of the parietal.

The bones of the skull on the whole were not thick, the parietals and the occipital varying from 5 to 7 mm. A study of the left half of the cranial mass leads us to the conclusion that the original skull was not a wide one; probably its maximum transverse diameter was about 140 mm.

The characters of the skull of Skhūl VI agree with those of the limbs in exhibiting male characters. The mastoid process is modern in its size and conformation, and so was the temporo-mandibular region. The attachments for the neck were strong and extensive and manifest certain Palaeoanthropic features.

CRANIA

Table LXXIII. THE CRANIA (LENGTHS AND CAPACITY)

	Tabūn I	*Skhūl I*	*Negro (child)*	*(Skhūl)* *IV*	*V*	*IX*	*Gibraltar*
Length:							
glab.-occip. M 1	183·0	(167·0)	170·0	(206·0)	192·0	(213·0)	190·0
ophryo-occip. M 1 *b*	173·0	(176·0)	166·0	(193·0)	179·0	(200·0)	183·0
nasion-inion M 2 *a*	178·0	(147·0)	148·0	(193·0)	180·0	(202·0)	181·0
glab.-inion M 2	179·0	(156·0)	152·0	(202·0)	190·0	(212·0)	186·0
intracranial M 4*	161·0	(163·0)	165·0	(176·0)	167·0	(187·0)	162·0
Thickness cranial wall:							
behind glabella†	19·0	..	3·0	(23·0)	23·0	(20·0)	21·0
right occipital pole	6·0	2·0	2·0	8·0	7·0	7·0	9·0
Cranial capacity‡	1,271	1,140	1,152	1,554	1,518	1,587	1,270

* Intracranial length of the right side.

† Includes the frontal crest.

‡ Pearson's inter-racial formulae (Martin, 1928, vol. ii, p. 647).

Table LXXIV. THE CRANIA (WIDTHS)

	Tabūn I	Skhūl I	Negro (child)	Skhūl IV	V	VI	IX	Gibraltar	Galilee
Width:									
greatest M 8	141·0	121·0	121·0	(148·0)	143·0	(143·5)	(145·0)	(146·0)	(138·0)
intracranial*	130·0	116·0	118·0	(136·0)	134·0	..	(133·0)	(130·0)	..
upper facial M 43	113·0	(86·0)	86·0	(133·0)	122·0	..	(124·0)	(118·0)	119·0
minimum frontal M 9	98·0	(84·0)	84·0	(106·0)	99·0	..	(96·0)	(107·0)	97·0
maximum frontal M 10	121·5	100·0	102·5	(121·0)	114·0	..	(120·0)	(125·0)	113·0
bi-asterionic M 12	120·0	106·0	97·0	132·0	122·0	(140·0)	(120·0)	(110·0)	..
Index:									
length-breadth	77·0	72·4	71·1	71·8	74·5	..	68·0	76·8	..
length-breadth (intra-cranial)	80·7	71·1	71·5	75·1	80·2	..	72·2	80·2	..

* Measured at the site of the greatest cranial width.

Table LXXV. THE CRANIA (HEIGHTS AND CIRCUMFERENCES)

	Tabūn I	Skhūl I	Negro (child)	Skhūl IV	V	IX	Gibraltar	Galilee	La Chapelle	Le Moustier*
Height:										
basi-bregmatic M 17	(115·0)	(114·0)	118·0	(128·0)	(129·0)	(130·0)	(117·0)	..	131·0	128·5
auricular (maximum)†	105·0	(104·0)	106·5	(114·0)	121·0	(116·0)	(103·0)	(118·0)	114·0	114·0
auriculo-bregmatic M 20	98·0	(101·0)	102·5	(112·0)	117·0	(113·0)	(93·0)	(116·0)	109·0	107·0
calotte M 22	84·5	(95·0)	96·0	(98·0)	100·0	(87·0)	(83·0)	(93·0)	77·0	90·0
Index:										
length-height	62·8	68·2	69·4	62·1	67·1	61·0	61·5	..	62·9	65·5
width-height	81·5	94·2	97·5	86·5	90·2	89·6	80·1	..	84·0	85·7
length-max. ear height	57·3	62·2	62·6	55·3	63·0	54·4	54·2	..	54·8	58·1
calotte height	47·2	60·9	63·1	48·5	52·6	41·0	44·6	..	40·5	47·3
Circumference:										
vertical transv. M 24	292	(284)	298	(315)	305	(320)	(276)	..	315	..
horizontal M 23 *a*	500	(458)	466	(580)	523	(560)	(522)	..	563	534

* Weinert, 1925. † Maximum vertical height of vault above the Frankfort plane.

Table LXXVI. THE CRANIA (ARCS AND CHORDS OF THE VAULT)

	Tabūn I	Skhūl I	Negro (child)	Skhūl IV	V	IX	Gibraltar	Galilee	La Chapelle	Austra-lian	Croma-gnon
Median sagittal arc M 25	(333·0)	(331·0)	341·0	(403·0)	373·0	(379·0)	(342·0)	..	357·0	374·0	403·0
Frontal:											
arc M 26	107·0	(112·0)	114·0	(132·0)	118·0	(130·0)	(124·0)	125·0	120·5	130·0	147·0
chord M 29	96·0	(98·0)	101·0	(118·0)	106·0	(114·0)	(107·0)	113·0	107·0	114·0	125·0
subtense	19·0	(27·0)	27·0	(28·0)	21·0	(25·0)	(21·0)	17·0	23·5	19·0	31·5
Parietal:											
arc M 27	117·0	114·0	126·0	(134·0)	131·0	120·0	..	..	118·5	140·0	130·0
chord M 30	105·0	107·0	114·0	(122·0)	120·0	112·0	..	..	112·0	124·0	119·0
Occipital:											
arc M 28	(108·0)	105·0	101·0	(122·0)	124·0	(129·0)	106·0	..	116·3	104·0	126·0
chord M 31	(90·0)	87·0	83·0	(86·0)	98·0	(95·0)	81·5	..	91·2	86·5	100·0
subtense	(29·0)	28·0	27·0	(26·0)	34·0	(36·0)	31·0	..	34·0	24·0	28·5
ratio subtense-chord	32·2	32·2	32·5	30·2	34·7	37·8	38·0	..	37·2	27·7	28·5

Table LXXVII. THE CRANIA (Angles of the Face and Base; Diameter of the Foramen Magnum)

	Tabūn I	*Skhūl I*	*Negro (child)*	*Skhūl* *IV*	*Skhūl* *V*	*Skhūl* *IX*	*Gibraltar*	*La Chapelle*
Angle:								
frontal*	65°	90°	100°	62°	63°	67°	55°	57°
facial M 72	92°	(88°)	84°	97°	73·5°	93°	88°	82°
symphysial M 79 (1)	48°	65°	61°	71°	63°	..	..	61°
'muzzle'†	140°	153°	145°	168°	136·5°	..	..	143°
sphenoidal M 36 *a*	..	..	..	..	117·5°	..	123°	135°
Diameters:								
basion-nasion M 5	(108·0)	(85·0)	85·0	(110·0)	100·0	(115·0)	106·0	123·4
basion-prosthion M 40	(102·0)	(83·0)	85·0	(105·0)	115·0	(106·0)	108·0	124·8
Foramen magnum:								
length M 7	(36·0)	(34·0)	36·0	(40·0)	37·0	..	(38·0)	46·0
width M 16	(28·0)	(28·0)	27·0	..	29·5	..	..	30·0

* The angle included between the Frankfort plane and a line tangent to the supraorbital torus and the metopion.
† The sum of the facial and symphysial angles (Figs. 172, 173).

Table LXXVIII. THE CRANIA (Facial Lengths and Widths)

	Tabūn I	*Skhūl I*	*Negro (child)*	*Skhūl* *II*	*Skhūl* *IV*	*Skhūl* *V*	*Skhūl* *IX*	*Gibraltar*	*La Chapelle*	*Australian*
Length:										
total facial M 47	118·0	(78·0)	81·5	..	(135·0)	126·0	..	..	131·0	107·0
upper facial M 48	79·0	(48·0)	46·0	..	(79·0)	73·0	(74·0)	78·5	86·0	66·0
Width:										
bi-zygomatic M 45	(130·0)	..	96·0	..	(160·0)	145·0	(140·0)	(134·0)	153·0	135·0
bi-maxillary M 46	..	..	75·0	..	(92·0)	110·0	(90·0)	103·0	110·0	97·0
inner biorbital M 43 (1)	102·0	(78·0)	80·0	(104·0)	(117·0)	(111·0)	(108·0)	106·0	112·0	103·0
anterior interorbital M 50	(32·0)	(22·0)	21·0	(28·0)	(33·0)	(28·0)	(35·0)	26·0	..	29·0
bi-dacral M 49 *a*	(28·0)	..	18·6	..	..	(24·0)	(30·0)	24·8	..	25·0
bi-malar M 45 (1)	..	..	88·0	..	(142·0)	136·0	..	115·0	125·0	118·0

Table LXXIX. THE CRANIA (Projected Measurements of the Face)*

	Tabūn I	*Skhūl* *IV*	*Skhūl* *V*	*Skhūl* *IX*	*Gibraltar*	*La Chapelle*	*Australian*
Projection from mid-auricular plane:							
ophryon	88·0	97·5	91·0	(104·0)	95·0	98·0	101·0
glabella	99·0	111·0	99·5	(113·0)	103·0	113·0	104·0
nasion	97·5	106·0	89·0	(107·0)	100·0	106·0	97·0
dacryon	87·0	93·0	82·0	(94·0)	89·0	96·0	84·5
lat. orbital margin	(76·0)	76·0	74·0	(81·0)	74·0	79·0	71·0
anterior point of ascending maxilla	100·0	116·5	..	(107·0)	107·0	118·0	100·0
zygomaxillare	(66·0)	77·0	74·0	(79·0)	69·0	72·0	73·0
lat. nasal margin	92·0	97·0	92·0	(99·0)	99·0	108·0	94·0
prosthion	96·0	97·0	110·0	..	102·0	117·0	106·5
infradental	90·0	91·0	104·0	..	..	103·0	102·0
pogonion	70·0	82·0	88·0	..	..	94·0	96·0

* The projected measurements of the face are illustrated in Figs. 172–3, 190, 195, 200 and are discussed on pp. 240–3, 259–60, 262–3, 272–4, 285–6.

Table LXXX. THE CRANIA (Orbits and Nose)

	Tabūn I	Skhūl IV	Skhūl V	Skhūl IX	Galilee	Gibraltar	La Chapelle	Krapina C	Cromagnon
Orbit:*									
width M 51	(42·0)	(44·0)	46·0	(44·0)	(44·0)	46·0	47·0	42·0	48·8
height M 52	(33·0)	(34·0)	(30·0)	37·0	(37·0)	39·0	37·0	38·0	30·6
Nose:									
height M 55	58·0	(55·0)	(53·0)	(55·0)	..	58·5	62·5	..	51·7
width M 54	(34·0)	30·0	(28·0)	(30·0)	..	34·5	34·0	..	25·8
index	58·6	54·5	52·8	54·5	..	58·9	54·4	..	50·0
length lateral border M 56 (2)	25·0	..	..	..	..	24·5	..	..	..
Nasalia:									
least breadth M 57	(20·0)	(16·0)	7·2	..	..	14·5	..	..	9·0
subtense at pt. of least breadth	..	..	..	..	..	4·0	..	..	4·1

* Orbital measurements are for the right orbit except in the case of Skhūl IV. The Cromagnon individual is the male from the Grottes des Enfants.

Table LXXXI. THE CRANIA (Temporo-mandibular Region)

	Tabūn I	Skhūl I	Skhūl IV	Skhūl V	Skhūl IX	Gibraltar	La Chapelle	Australian
Mandibular fossa:*								
length	22·0	..	34·5	19·0	..	18·0	25·0	18·0
width	23·0	(10·0)	24·0	26·0	..	22·5	29·0	22·5
height	0·0	..	0·0	0·0	..	2·5	..	3·5
depth	5·0	..	6·0	5·0	..	4·5	..	8·5
Height of temporal line†	80·0	60·0	85·0	115·0	85·0	75·0	..	100·0
Height of sagittal suture†	145·0	135·0	152·0	160·0	153·0	(135·0)	..	152·0
Auditory meatus:								
height (vert. diam.)	8·0	..	10·0	9·0	..	6·0	8·2	10·0
width (a-p. diam.)	11·0	..	7·5	7·0	..	8·5	11·0	7·0

* Definitions of the measurements of the temporo-mandibular joint are given on p. 246.

† The height of the upper temporal line and of the sagittal suture is the distance, measured with a steel tape, 15 mm. behind and parallel to the coronal suture, which each of them lie above the upper border of the zygomatic arch.

Table LXXXII. THE CRANIA (Nuchal and Mastoid Areas)

	Tabūn I	Skhūl I	Negro (child)	Skhūl IV	Skhūl V	Skhūl VI	IX	Gibraltar	La Chapelle	Cromagnon
Projected distance of inion from mid-auricular plane	76·0	68·0	62·0	87·0	89·0	(90·0)	98·5	79·0	91·0	82·0
Length nuchal plane*	71·0	63·0	55·0	82·0	85·0	..	95·0	72·0	86·0	79·0
Width:										
bi-mastoid (lateral)†	136·0	(104·0)	100·0	(141·0)	130·0	(136·0)	(136·0)	(128·0)	138·0	133·0
bi-mastoid (tips) M 13	122·0	(88·0)	86·0	(129·0)	111·0	..	(130·0)	(96·0)	121·0	..
Depth of mastoid‡	17·5	17·5	14·0	26·0	26·0	(30·0)	(21·0)	18·5	24·0	..
Depth of paramastoid‡	19·0	..	..	23·0	18·0	(20·0)	20·0	21·5	..	..
Angle of nuchal plane§	17·5°	..	..	9°	10°	..	19°	9°	17°	..

* The nuchal plane is defined on p. 247.

† Taken between the most distant points on the lateral aspects of the mastoid processes (attachment of the sterno-mastoids).

‡ Projected distance of the most inferior point below the Frankfort plane.

§ Angle included between the nuchal plane and the Frankfort plane.

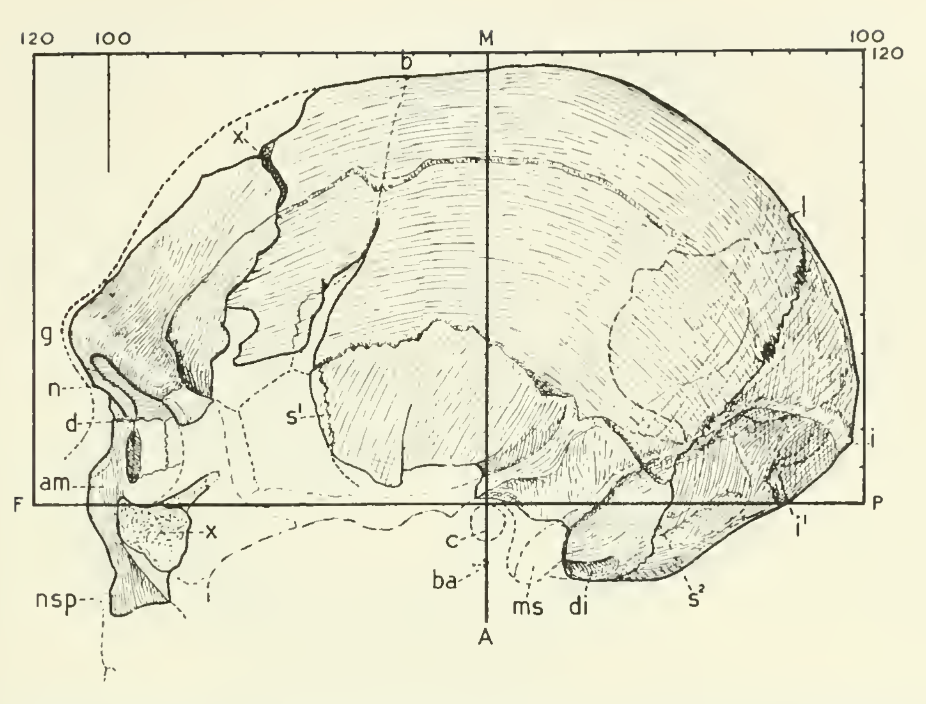


FIG. 200. SKHŪL IX, IN NORMA LATERALIS (RECONSTRUCTION BASED ON THE PRESERVED PORTIONS OF THE RIGHT AND LEFT SIDES). Missing parts are represented by a broken line. *g*, glabella; *b*, bregma; *l*, lambda; *i*, inion; i^1, internal inion; *d*, dacryon; *am*, ascending process of maxilla; *x*, fractured surface of maxilla; *nsp*, position of nasal spine; s^1, spheno-temporal suture (placed on the reconstructed great wing of the sphenoid); *c*, auditory meatus; *ba*, inferred position of basion; *ms*, reconstructed mastoid process; *di*, diagastric fossa; s^2, masto-occipital suture; x^1, fracture across hinder part of right frontal.

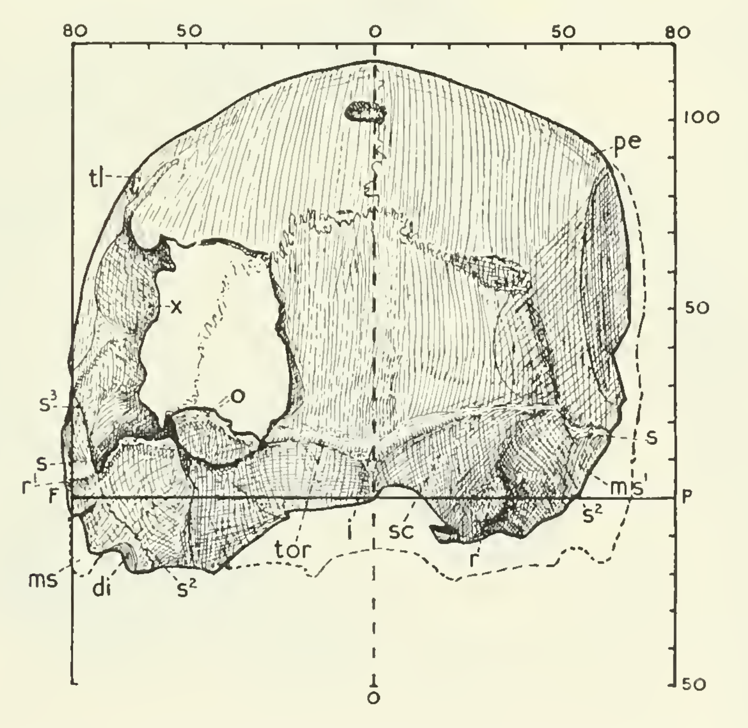


FIG. 201. SKHŪL IX, IN NORMA OCCIPITALIS (RECONSTRUCTION). The Frankfort plane is that used in Fig. 200. *i*, inion; *tor*, torus occipitalis; *sc*, insertion of semispinalis capitis; *r*, ridge between the areas for the semispinalis capitis and obliquus capitis superior; *s*, masto-parietal suture; s^2, masto-occipital suture; *di*, digastric fossa; *ms*, restored mastoid process; r^1, ridge for sterno-mastoid muscle; s^3, squamous suture; ms^1, posterior part of left mastoid process; *x*, anterior and inner margin of perforation; *o*, fragment of occipital deflected outwards, carrying part of occipital torus; *pe*, parietal eminence (right); *tl*, temporal lines (left). The stippled line represents missing parts.

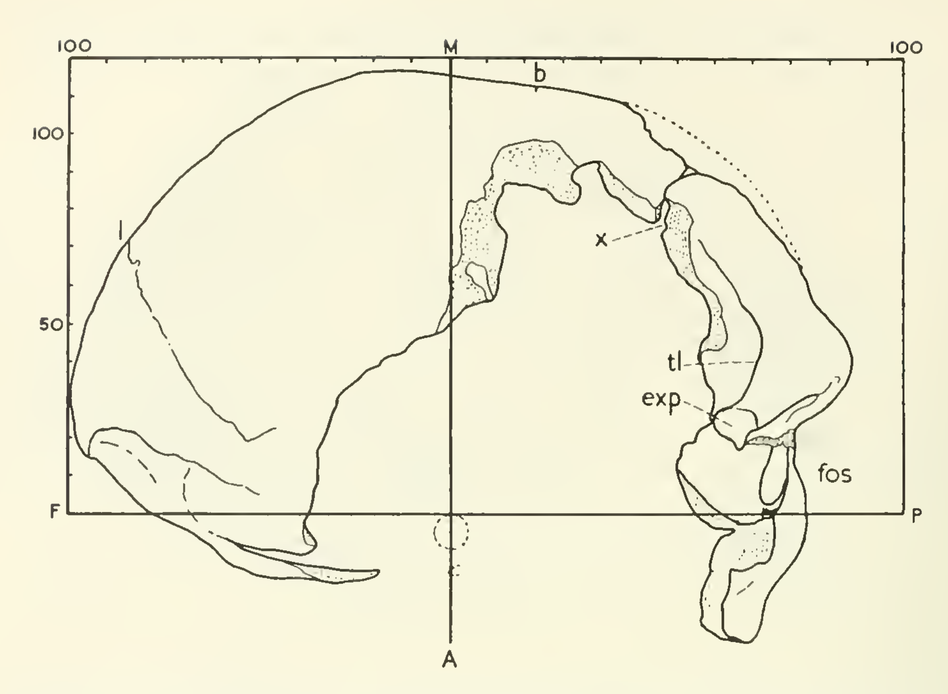


FIG. 202. SKHŪL IX, TRACING, RIGHT LATERAL ASPECT. The skull is here shown with a length of 206 mm. The portion is the same as that used for Figs. 200–4, but the more backward position of the orbitale necessarily alters the cranial relationships with respect to the Frankfort plane, and of the frontal bone and face to the other parts of the vault and base. The same orientation is used in Figs. 203–7. Stippled areas indicate fractured surfaces. *x*, fracture across the frontal bone.

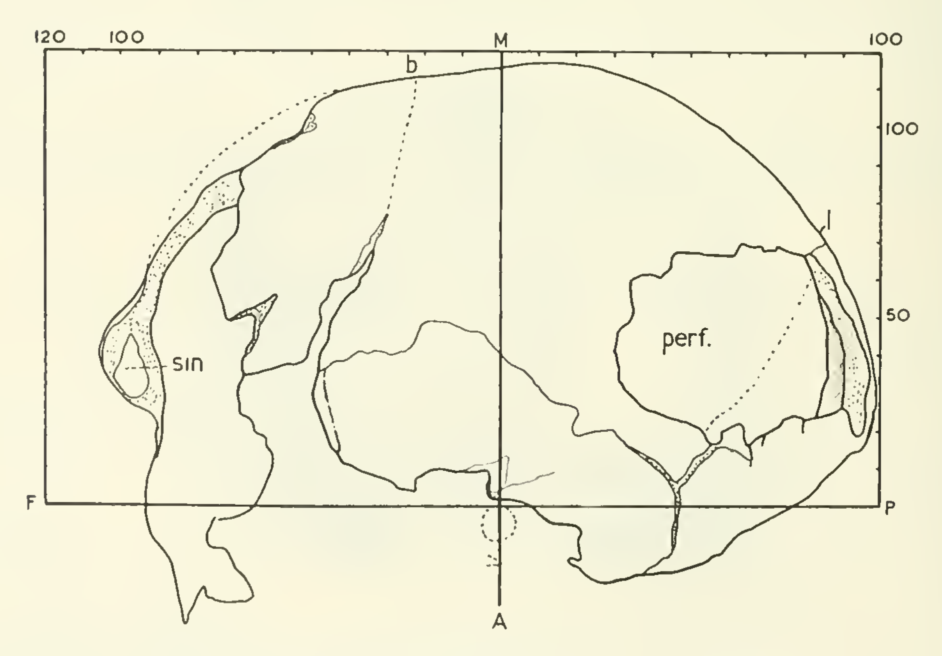


FIG. 203. SKHŪL IX, OUTLINE TRACING, LEFT LATERAL ASPECT.

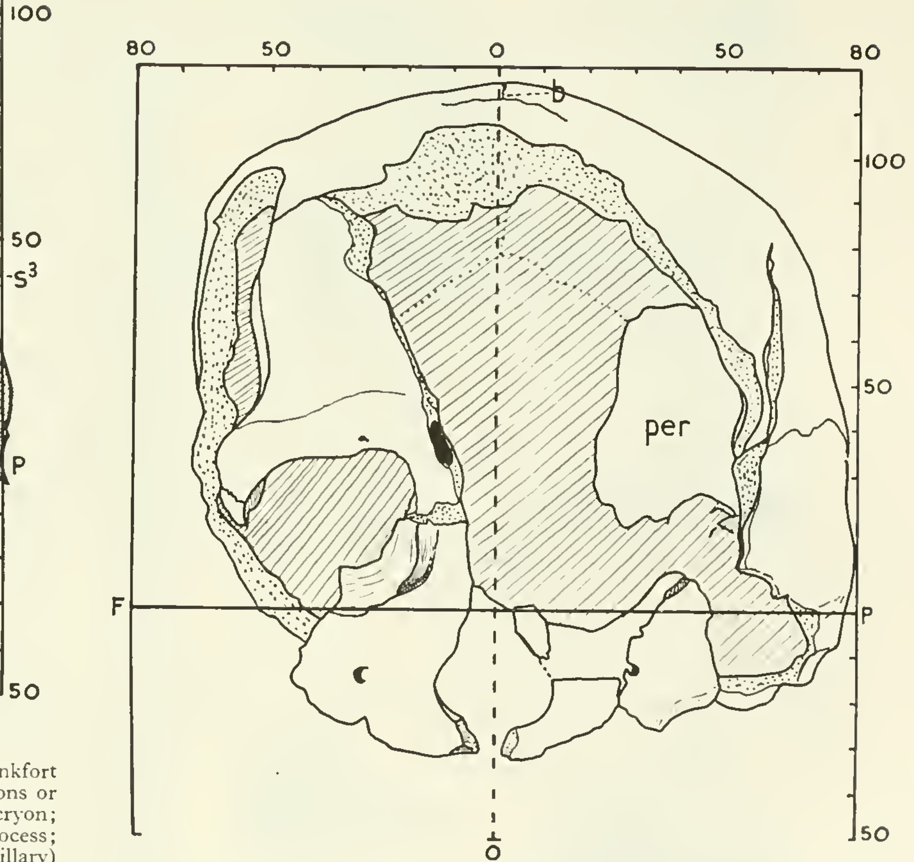


Fig. 204. Skhūl IX, in Norma Frontalis (Reconstruction). The Frankfort plane is that determined for Figs. 200, 202. Broken lines represent restorations or duplications. *b*, bregma; *g*, position of glabella; *n*, position of nasion; *d*, dacryon; *x*, fractured medial end of right supraorbital torus; *exp*, external angular process; *mal*, attached fragment of malar; s^3, squamous suture; *bor*, anterior (maxillary) border of lachrimal fossa; *fos*, lachrimal fossa; x^1, fractured surface of maxilla; *nas*, sharp margin of nasal aperture; *am*, ascending process of maxilla; *y*, angular projection at lower end of naso-maxillary suture; *can*, infraorbital canal.

Fig. 205. Skhūl IX, Outline Tracing, Facial Aspect. The occipital wall is shown with lambdoid suture indicated. *per*, perforation.

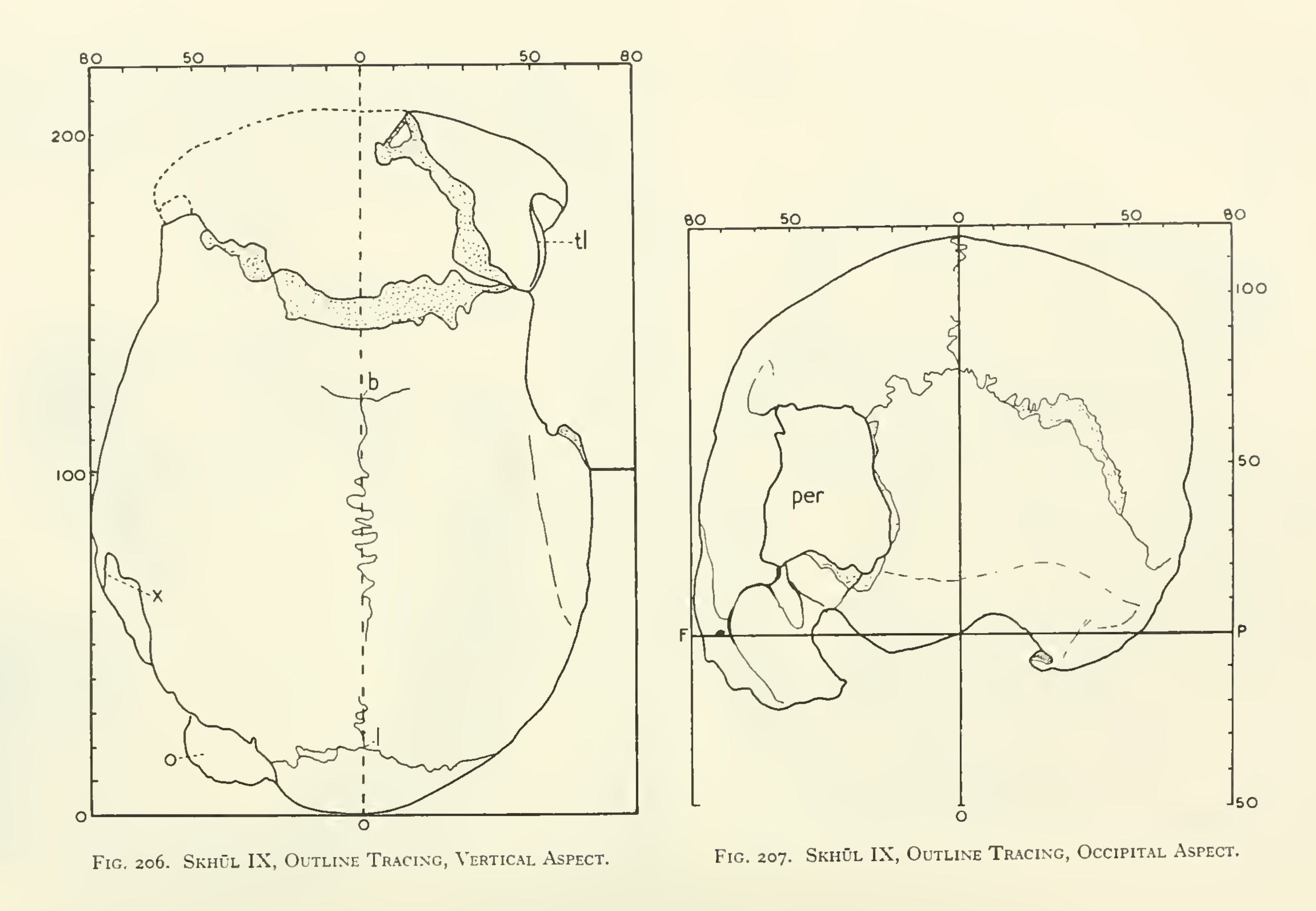


Fig. 206. Skhūl IX, Outline Tracing, Vertical Aspect.

Fig. 207. Skhūl IX, Outline Tracing, Occipital Aspect.

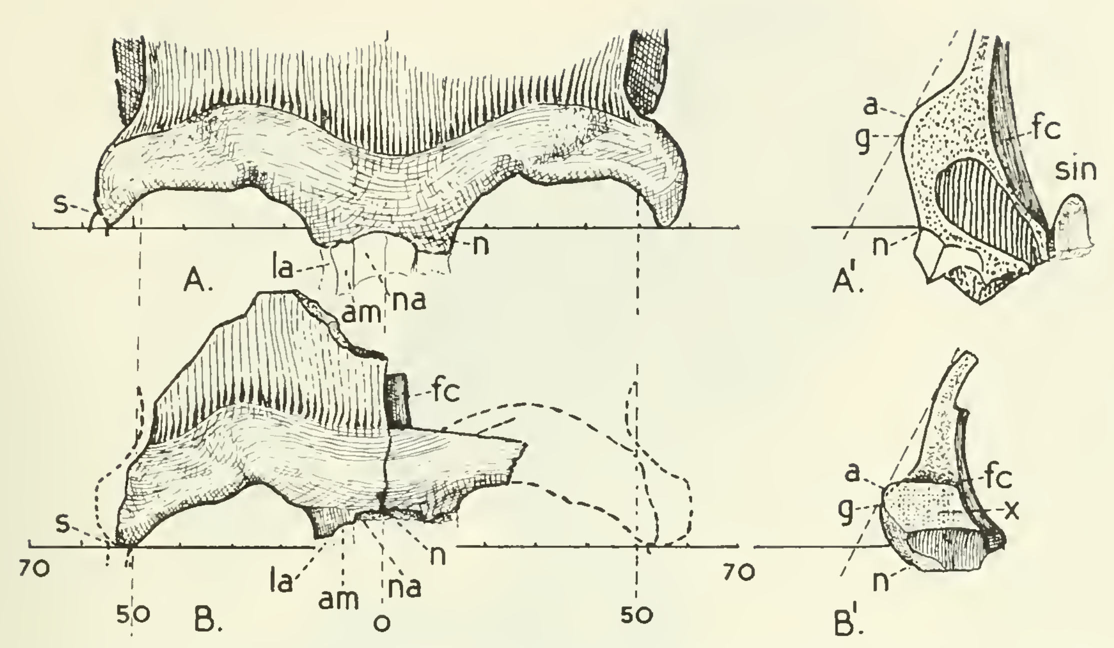


Fig. 208. The Supraorbital Torus, Anterior Aspect with the Respective Sagittal Section. A, A′, Galilee; B, B′, Skhūl II. *a*, projection of torus lateral to the glabella; *g*, glabella; *x*, sagittal section of the left supraorbital at position of supraorbital foramen; *n*, nasion; *sin*, frontal sinus; *fc*, frontal crest; *na*, attachment for nasal bone; *am*, attachment for ascending process of maxilla; *la*, attachment for lachrimal; *s*, fronto-malar suture.

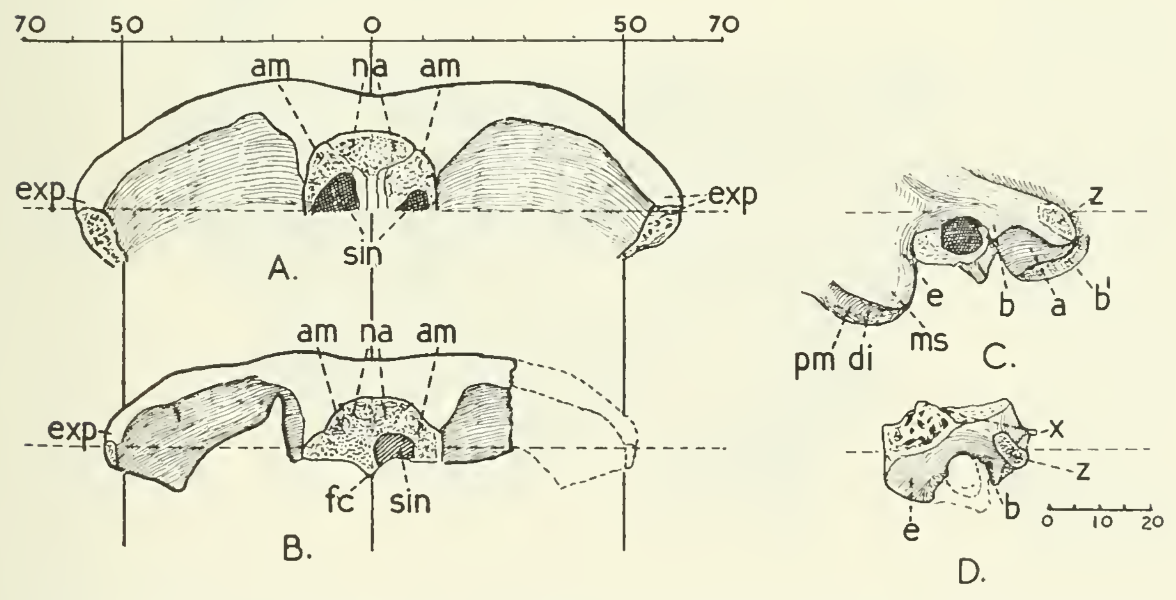


Fig. 209. Inferior Aspect of the Frontal Bone, Showing the Roofs of the Orbits. A, Galilee; B, Skhūl II. *na*, attachment for nasal bones; *am*, attachment for ascending processes of maxilla; *sin*, frontal sinus; *exp*, external angular process; *fc*, fractured lower end of frontal crest. Lateral Aspect of the Left Auditory Region. C, Gibraltar; D, Skhūl II. *z*, root of zygoma; *b′*, medial (sphenoid) prominence; *a*, articular surface of mandibular fossa; *b*, post-glenoid spine; *e*, post-meatal surface of mastoid; *ms*, mastoid process; *di*, digastric fossa; *pm*, paramastoid prominence; *x*, thin plate forming roof of mandibular fossa.

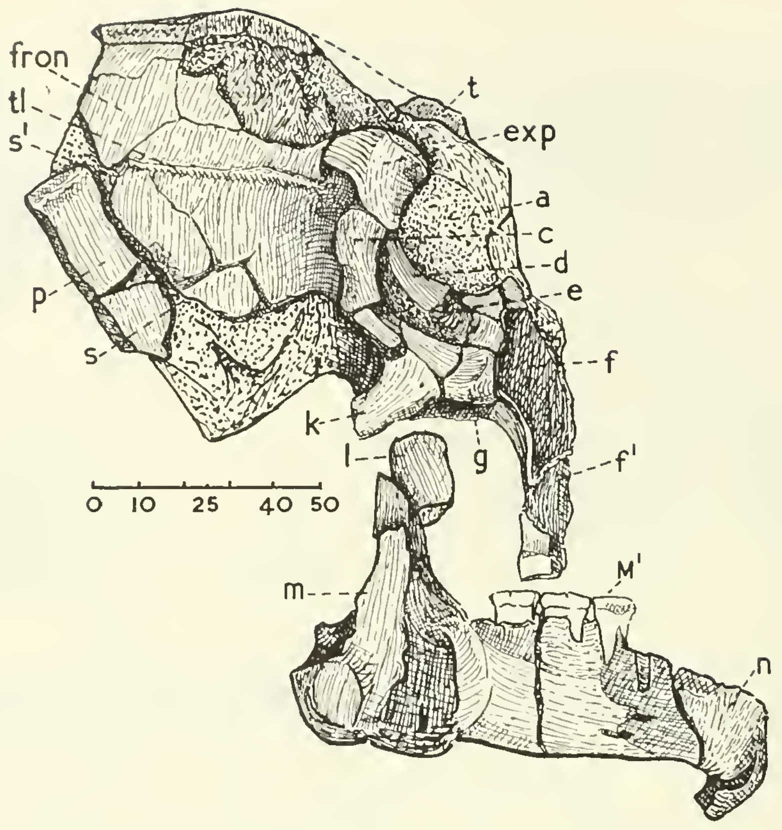


FIG. 210. SKHŪL VII. RIGHT LATERAL ASPECT OF THE CRUSHED SKULL AND MANDIBLE. *a*, socket of the right orbit (outlined in breccia; stippled); *exp*, external angular process; *c*, *d*, temporal and orbital parts of ascending process of the malar; *e*, crushed body of the malar; *f*, maxillary sinus (filled with breccia); *f'*, vault of palate; *g*, fragment of angular part of the malar; *k*, zygomatic process of malar, with ridge for origin of masseter; *l*, coronoid process of mandible; *m*, crushed and incomplete ascending ramus; *n*, symphysial region of mandible; *s*, lower end of coronal suture; *p*, fragment of right parietal; *s*¹, middle part of right coronal suture; *tl*, temporal line; *fron*, right frontal; *t*, supraorbital region of left frontal.

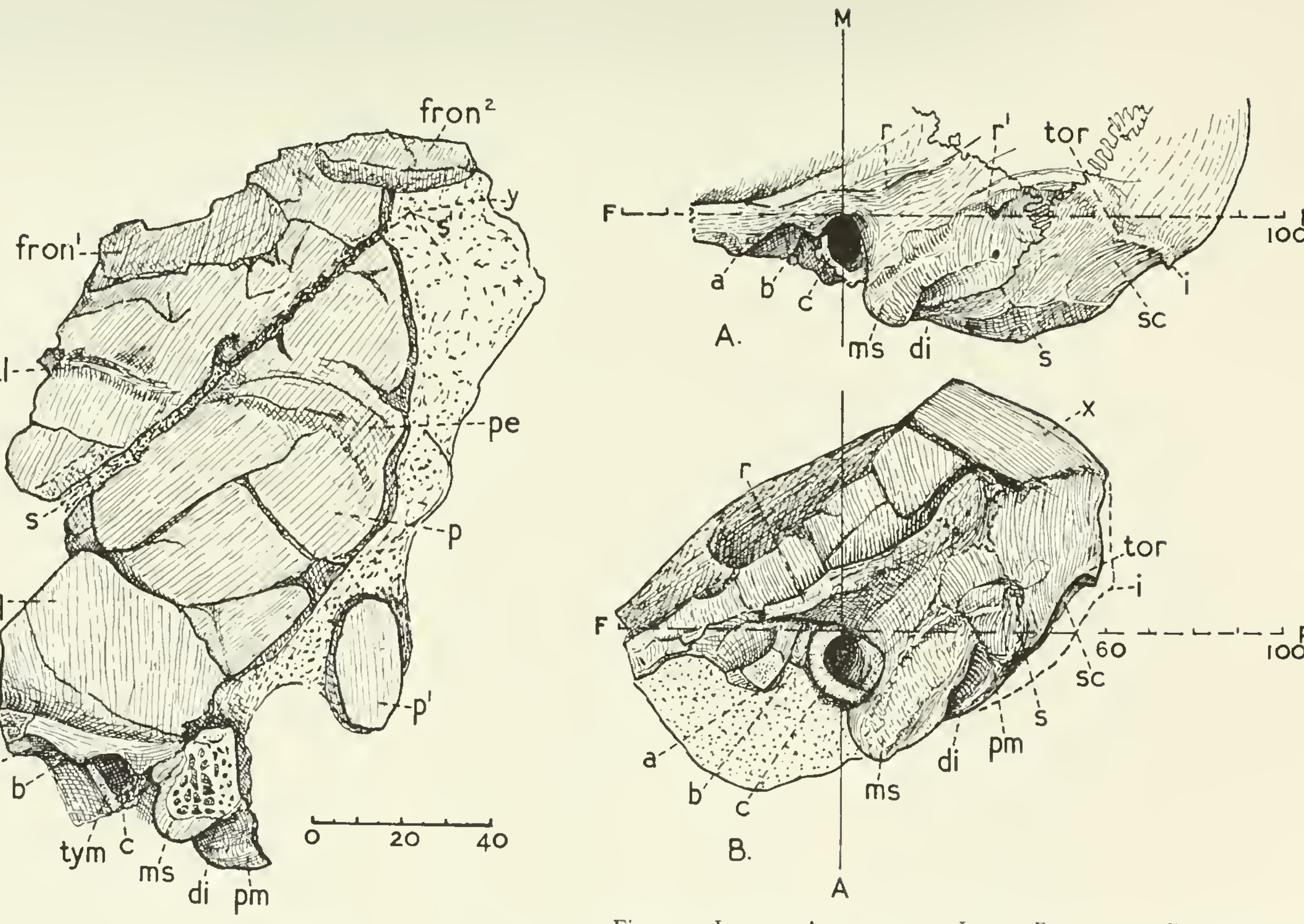


FIG. 211. SKHŪL VII. LEFT LATERAL ASPECT OF THE CRUSHED SKULL. *s*–*s*¹, coronal depression (*s*¹, indicates the approximate site of the bregma); *y*, upper end of right coronal suture; *fron*¹, supra-orbital region of left frontal; *fron*², upper part of right frontal; *p*, left parietal; *pe*, parietal eminence; *sq*, left squamosal; *tl*, temporal ridge; *z*, root of zygomatic process; *a*, articular tubercle; *b*, post-glenoid spine; *tym*, tympanic plate; *f*, auditory meatus; *ms*, tip of mastoid process; *di*, digastric fossa; *pm*, paramastoid eminence; *p*¹, detached part of parietal near mastoid angle.

FIG. 212. LATERAL ASPECT OF THE LOWER PART OF THE POST-AURICULAR REGION OF THE SKULL. A, Australian (male); B, Skhūl VI. In A the drawing has been made at right angles to the sagittal plane, with the skull orientated on the Frankfort plane. In B the post-auricular part of the skull is foreshortened (cf. p. 293). The Frankfort plane is inferred for Skhūl VI. *a*, tuberosity at the root of zygomatic process; *b*, post-glenoid spine; *c*, tympanic plate, forming anterior wall of meatus; *ms*, mastoid process; *di*, digastric fossa; *pm*, paramastoid eminence; *s*, occipito-mastoid suture; *i*, inion; *sc*, insertion for semispinalis capitis; *r*, supra-meatal ridge; *r*¹, supra-mastoid crest; *tor*, occipital torus; *x*, parieto-occipital fragment.



CHAPTER XIX

JUVENILE SPECIMENS

SKHŪL I. CRANIAL AND FACIAL CHARACTERS

THIS child's skull and skeleton were the first of the human remains to be brought to light in the strata of the Levalloiso-Mousterian period in the Wady Mughara sequence of prehistoric cultures. Its discovery in 1931 and the facts concerning its position in the Skhūl deposit have been recounted by one of us in Volume I of *The Stone Age of Mount Carmel* (pp. 97–8). The block containing the skull and skeleton was shipped to the Museum of the Royal College of Surgeons, and the delicate task of chiselling the breccia away to expose the bones was entrusted to the experienced hands of Mr. Ernest Smith, who began work on it in September 1931.[1]

The general scheme of preparation of these fossil specimens, then evolved by Sir Arthur Keith and Mr. Smith, and employed subsequently by Mr. McCown and Miss Collett for the skeletons discovered at the Wady Mughara in 1932, is worthy of record. We propose, therefore, to present to our readers an account of the various stages in the removal of the Carmel child from the enclosing hard matrix.

A plan of the block is shown in Fig. 213. In height it measured 26·5 cm., its north or 'dorsal'[2] and south or 'ventral' sides—using its original position in the terrace as indication—31 cm.; its east (left) and west (right) sides 36 cm. The block was marked out into horizontal strata, each 5 cm. deep (Fig. 213), and the strata numbered from above downwards, 1–4. Mr. Smith worked his way down the block stratum by stratum, keeping an accurate plan on which everything was registered as objects were met with in each stratum.

In removing stratum 1 the following parts were exposed: the right aspect of the hinder half of the skull—the right parietal eminence, the right temporal—with external meatus and temporo-mandibular fossa all approximately on the same level. A large fragment of the anterior part of the right parietal had been broken away, exposing the impression of the meningeal grooves on the hard endocranial cast which filled the skull. The frontal bone, with its cerebral surface uppermost, lay as is shown in Fig. 214, its upper or coronal border lying adjacent to, but unconformable with, the buried coronal border of the right parietal. Eight teeth, which had been contained in the upper jaw, lay scattered as shown in Fig. 214, all being separate and firmly embedded in the breccia. Six large flakes lay at this level. None of them showed secondary working.

Stratum 2. The whole length of the left humerus (Fig. 214, 5) became exposed in this stratum. The distal or elbow end lay exposed on the 'ventral' side of the block; its shoulder end lay to the left of the skull. No trace was seen of the epiphyseal ends of this bone—only the diaphysis or shaft. One of the ribs—of the right side and about the sixth of the series—became exposed between the left humerus and skull. Of the left forearm

[1] Mr. Smith carried on the work until January 1932, at which time Mr. McCown took over the task of cleaning out the interior of the skull. Further work on the skull and skeleton was done in 1933 and 1934.

[2] In describing the position of the child it will be convenient to speak of the relationship of the block to the contained child, hence the introduction of the terms dorsal (N.), ventral (S.), left (E.), and right (W.).

and left hand the only part found is the shaft of the left radius (Fig. 214, 2) which was embedded in the hard breccia filling the skull. From this position we infer that the left arm must have been flexed at the elbow and the left forearm and hand placed against the side of the head and face at the time of burial.

The skull now became exposed so as to display its whole depth; it was seen to rest on its *left* parietal eminence (Fig. 216). For the skull to assume this aspect and to lie well to the right side of the body, with the left radius detached and embedded within the skull, one must presume that a disturbance took place after burial but before the skull became filled with its rock-like filling. As to the nature of this disturbance we shall offer an explanation later. A second upper milk molar was also found at this level. It was now seen that the hinder part of the foramen magnum was preserved, the whole of the occipital, the right temporal, the sagittal suture, and the frayed, fragmented coronal borders of the parietals (Figs. 214, 215, 216).

Stratum 3. In this stratum it became possible to detach the skull, leaving a smooth cup of breccia in which the left parietal had rested. The 'cup' bore the impression of the lambdoid suture showing that the skull rested on the left side of the occipital as well as on the hinderpart of the left parietal. Between the impression or cup formed by the skull and the left humerus now appeared additional ribs of the right series, and also the bones of the right lower limb—the femur and tibia (Fig. 214). Thus the body of the child must have been placed in the grave with the body leaning somewhat towards the left, and the right leg and ribs rather more superficial than those of the left side. Under the cranial cup was found the upper central incisor of the milk set. In this stratum 15 chips or flakes were found.

Stratum 4. The cup of breccia which supported the skull was removed. In this stratum the lowest level of the burial was reached. It was now seen that the bone exposed on the left face of the block was the left os innominatum (Fig. 216, *l.il*); with it lay the upper part of the sacrum (*sac.*). The upper end of the left femur (*l.f.*) now became distinguishable and the left knee which lay at a deeper level than the right (Fig. 215). The left ribs—beginning with the fourth or fifth of the series—lay between the left os innominatum and the left femur (Fig. 215). As the body decayed and sagged downwards under the weight of soil, the ribs were forced downwards on the thighs. In this stratum were a series of flints, not worked.

In Fig. 214 a combined tracing has been made of the parts found in the four strata, so that the parts of the skeleton are displayed as if the spectator looked into the grave from above. We see that the right leg is flexed under the right thigh, with foot under right buttock; left leg bent under left thigh with foot under left buttock; the legs lie in the deepest part or floor of the grave, the knees directed towards the ventral side of the block and hips and buttocks towards the dorsal side. The left knee lies under the right and the left hip is the deeper in the grave. The left ribs lie just inside the left half of the pelvis and outside the left femur, while the right ribs lie inside the right femur. The body had been buried in a kneeling position with flexed body, the ventral aspect turned towards the cave, the back towards the valley. The upper end of the left humerus marks the position of the left shoulder—which is over and in front of the left hip.

All the bones just mentioned lie in a natural relationship—one which they would assume if the child had been buried in the position described—in a kneeling position, with body

flexed forward, and with its left side resting against the side of the grave, with the left arm flexed, elbow forward and forearm and hand under the head. The right shoulder and arm bones should have occupied a higher level than those of the left. If the burial had been undisturbed we should have found the skull near the left shoulder with all parts of its face and jaws in position.

To account for the skull being in a broken state, with its occiput directed towards the knees and displaced to the right side of the body, we have to presume there had been a disturbance of the upper part of the body after burial. The disturbance must have been not long after interment, for the skull had been broken and the left radius driven within the upturned right side before its cavity became filled with a matrix of consolidated cave earth. An upper milk incisor lay beneath the skull; that might have dropped from the mouth before the disturbance. The fragments of the lower jaw lay over the site of burial; so did fragments of the right humerus; the upper teeth lay scattered to the left of the skull. In the disturbance the base of the skull had been shattered and of the left temporal bone only the detached petrous part is preserved.

The disturbance of the corpse or skeleton was not likely to have been caused by dogs or hyenas; there are no marks of teeth on the bones—save what seem to be due to some form of small rodent. Most likely the disturbance was caused by later cavemen digging into the terrace over the site of the burial and thus shifting and breaking the more superficial parts. The skull was displaced so that it came to lie on its left side with the face and forehead uppermost. The lower jaw was fractured, the face was broken off, the teeth scattered, and the forehead thrust away from the rest of the skull so that it came to occupy the position in which it was found. The nature of the digging instrument may be inferred from a rectangular perforation in the roof of the upturned right ear. The skull lay so that the right ear and right glenoid cavity was directed upwards. The perforation and fracture of the temporal is such as could be caused by a sharp-pointed stone implement. The blow had forced into the skull a narrow oblong area of bone. This fracture was caused before the skull became enclosed in its calcareous matrix. Another opening in the left parietal was made by a thrust given from above. We shall see that the skull shows other lesions—one on the forehead which was caused at or soon after death (Fig. 217; also pp. 309–10).[1] The parts of the right arm were also scattered; fragments of the right humerus were recovered from material which overlay the block containing the skeleton. That we have here a deliberate burial there can be no doubt; as to how the superficial parts became displaced and broken there is room for speculation.

In Fig. 215 a drawing is given of the skeleton as seen when viewed in profile from the left side, as if the block had been transparent. Below and in front of the skull is seen the head and neck of the left femur; beside it lie the lower ends of the left tibia and fibula. Beyond, but at a higher level, are the corresponding parts of the right limb. In front of the head of the left femur is all that remains of the left os innominatum beyond which are the upper sacral vertebrae. In front of the os innominatum come the lower left ribs, then the left knee-joint which hides the corresponding part of the right limb. More superficially lies the left humerus; the left radius stands vertically within the overturned skull, which has no left temporal; the frontal bone is overturned and displaced forward as already described.

[1] See also wound of the hip-joint of Skhūl IX (pp. 73–5).

In Fig. 216 a drawing is given of the skeletal parts as seen from the right side—the reverse of the last. The overturned frontal is shown; the hinder part of the skull presents its left parietal aspect and the upper (anterior) part of the sagittal suture. The proximal (shoulder) end of the left humerus lies over the right ribs; then come the right femur and the lower (distal) parts of the right tibia and fibula. The right leg is less acutely flexed on the femur than is the case of the left limb. Beyond the lower end of the right tibia come the left tibia and fibula, then the head (proximal end) of the left femur. Above the head of the left femur are the sacral vertebrae and left os innominatum. In its vertical direction the area occupied by the bones of the skeleton measured 14 cm.; in a horizontal (cranio-caudal) direction 28 cm.; in a transverse—right to left—direction 27 cm.

Only four bones of the skeleton—the left humerus, left radius, left astragalus, and the vertebrae of the sacrum—were detached and cleaned. All the other bones of the body and limbs were exposed, but between them were left uniting pieces of the matrix, so that they remained firmly joined in the position they had assumed in the grave after burial. Further experience in the preparation of this fossil material convinced us that it was possible to attempt the 'disarticulation' of the child's skeleton and this was successfully accomplished. The individual bones are shown in Figs. 227–37 and in Pl. XXIII.

The hinder half of the skull was excellently preserved but was completely filled with the extremely dense matrix. The removal of its contents had to be accomplished somehow if a successful exposure of the brain markings was to be obtained. The walls of the skull were only 3 mm. in thickness in most parts; in some only 2 mm.—a mere shell. The matter, all but a buttress on the right side which was retained to strengthen this, the weakest part of the skull, was successfully removed after weeks of labour. Ultimately, this too was removed without damage to the fragile specimen, and a clearly marked endocranial impression was obtained (Figs. 240–4; Pls. XXIV, XXV).

Having thus given an account of the exposure of the skeleton by removal of the matrix and the position and state of preservation of its bones, we propose now to describe the various parts in the following order: (1) the teeth; (2) the mandible; (3) the various parts of the skull; (4) the whole skull. The bones of the skeleton are described in Chapter XX.

The Dentition

We give a detailed description of the dentition of the Carmel child for two reasons: (1) because of its importance in assessing the probable age of the child—which we estimate to have been about 4 or 4½ years of age reckoned on body development and on dental development; (2) because on the evidence of the teeth is based our identification of the child as a variety, breed, or race of the Neanderthal species. Altogether we have representations of 17 teeth—10 milk teeth and 7 permanent.

At the time of death all the milk teeth were erupted and in use, while the crowns of the first permanent molars lay within their alveoli, but were fully formed. Of the 20 teeth which constitute the milk dentition we have only 10, namely 5 upper teeth—i–1 (left); c (left); m–1 (right); m–2 (right and left); 5 lower—i–2 (left); c (right); m–1 (right); m–2 (right and left). There are seven crowns of the permanent dentition, viz. the crowns of all four first molars, upper central incisor (right), upper lateral incisor (right), upper canine (left). The crowns of the three teeth last named are imperfect, but sufficient to prove the peculiar nature of the Carmel race.

Milk Dentition

Only the crown of the upper left central incisor with a jagged piece of root is preserved. The pulp cavity is exposed and is large, being 4·2 mm. wide by 2·2 mm. in its labio-lingual diameter. The crown is remarkable for its width—being a millimetre more than any other sample at our disposal.[1] The labio-lingual diameter is absolutely and relatively small. The medio-distal diameter of the neck is 2 mm. less than the same diameter of the crown. The cutting-edge is bevelled on its lingual surface from wear; for a child of 4 years the wear is slight. The lingual tubercle forms a rounded eminence fading on the lingual aspect of the crown. The crown is very similar to that shown in Fig. 121 A.

Upper Canine (Fig. 137 A).

Had it not been that the right lower canine is preserved in the mandible one would have mistaken this for a lower tooth. The lingual aspect of the crown is less convex than in the lower canine. As will be seen from Fig. 137 A the cutting-edge is divided into two parts by a median projection or point; one part of the edge is transverse—for articulation with the lower canine by which it has been worn, and the other part of the edge—for articulation with the lower first milk molar, is oblique. The lingual tubercle forms a smooth convexity occupying half the height of the crown. The lateral or distal border of the crown forms a raised rounded margin which ascends from the basal tubercle. The medial or proximal border is not sharply defined. This tooth, compared with the upper milk canine of modern children, is of moderate size—smaller and larger examples being readily found. As in the upper incisor the labio-lingual diameter of the crown is relatively and absolutely small.[1]

First Upper Milk Molar (*Right*) (Pl. XIV, 7; Fig. 139 A).

This three-rooted tooth has attached to it a marginal part of the alveolar bone. The lingual root, single and strong, diverges from the body of the tooth towards the palate at a sharp angle, while the two buccal roots ascend directly from the body of the tooth. Both buccal roots were apparently small; they are both broken; the divergence of the lingual or palatal root is extreme—being 9·5 mm. distant from the stump of the buccal root. The labio-lingual diameter is less and the medio-distal diameter greater than is usual in the first milk molars of modern children.[1]

On the chewing surface, although polished by use, all four cusps of the upper molars are plainly demarcated. An Australian aborigine child which we have used for comparison has a much wider first milk molar (10 mm.), but less in a medio-distal direction (8·2 mm.); the greater width of crown in the Australian molar is due to a great eminence on the buccal aspect of cusp b–1 (paracone), this eminence being slight in the Carmel milk molar. Above the buccal eminence of the Australian molar is a pocket in the enamel (the paracone cingular pocket) which is only slightly developed on the Carmel molar. The number (4) and arrangement of cusps in the Australian and Carmel molars are remarkably similar. On the occlusal surface of both there is a prominent anterior (proximal) marginal ridge, behind which lies a linear anterior fovea. In both there is a prominent posterior (distal) marginal ridge, bounding a linear posterior fovea. In both

[1] Measurements are given in Table LXVIII (p. 212).

the l–2 cusp (hypocone) is really the lingual end of the posterior marginal ridge, but in the Carmel tooth the hypocone is separated from cusp l–1 (protocone) by a distinct fissure.

In front of the posterior fovea is a strong oblique ridge which joins l–1 and b–2 (metacone). On the occlusal aspect of b–1 (paracone) a rounded ridge descends behind the anterior fovea. In both Australian and Carmel molars the anterior marginal ridge ends at its buccal extremity in a well-marked conule—the protoconule. The chief differences between the Australian and Carmel first molars are: (1) the prominent buccal eminence on the paracone of the Australian; (2) the inward deflexion of the lingual root in the Mount Carmel molar; (3) the longer and narrower crown in the Mount Carmel specimen.

Upper Second Milk Molars (*Right and Left*) (Pl. XIV, 8; Fig. 139 B).

These are almost identical in crown pattern but differ slightly in dimensions, the right one being slightly the smaller. The body and part of the roots are still attached to the left tooth; only the crown of the right is present. The enamel has a crystalline appearance; only the apices of the cusps are worn. The corresponding upper milk molars of the Australian child have larger diameters—viz. 12 mm. (medio-distal) and 11 mm. (labio-lingual)—but cusp patterns are almost identical. The features of the Carmel molar crown are the following: (1) The presence on the lingual aspect of the l–1 cusp (protocone) of an enamel pocket—a miniature swallow's nest; as this is a stage in the development of a Carabelli cusp we shall speak of it as the Carabelli fossa. The fossa is present but less developed on cusp l–1 of the Australian molar. (2) A prominent anterior marginal ridge is continued on to the apex of cusp b–1 (paracone). (3) There is a mere trace of the anterior fovea. (4) The oblique ridge joining l–1 and b–2 is prismatic in section and forms a high boundary between the cup of the trigonid and the wide posterior fovea. (5) Cusp l–2 (hypocone) is almost as big as the protocone; the posterior marginal ridge joins it to b–2. Cusp b–2 (metacone) rises 2 mm. above the floor of posterior fovea. The enamel is not folded; on the Australian molar there is a tendency to the formation of distinct enamel folds and to the detachment of part of the folds as conules.

There are the usual three roots—two buccal and one palatal. The height of body—from bifurcation of outer roots to upper margin of crown—is 7 mm. The pulp cavity measured 5 mm. (l–l) and 6 mm. (m–d). The small size of the milk teeth supports our inference that the Carmel child was a girl. The slight degree of wear of the milk teeth, notwithstanding the complete development of the crown of the unerupted first permanent molar, may be due to a grit-free, easily masticated diet. Or was it a milk and flesh diet?

Lower Milk Teeth (Pl. XXII D; Figs. 137 F, 139 E).

The left lateral lower incisor is *in situ* in the mandible, but its crown has been damaged. Enough remains to give the dimensions (Table LXVIII, p. 212) and to show that the wear was on the labial aspect of the cutting-edge. There is a full rounded development of the lingual tubercle of the crown, which is continued towards the cutting-edge.

The lower right canine is *in situ* in the jaw; the features of its labial aspect are shown in Fig. 137 F. The cutting-edge is pointed, the point separating two equal-sized areas for contact with the upper lateral incisor and with the upper canine. The labial surface of the crown is more convex on its buccal and lingual aspects than in the case of the upper

canine. As with that tooth, so here, the crown tends to assume an incisor-like form. The lingual aspect of the crown is damaged but it is clear that the elevation at the lingual base of the crown was prominent.

The lower right first milk molar (Fig. 137 F) is preserved *in situ*, but unfortunately the crown has been much damaged so that the cusp pattern cannot now be deciphered. It is evident, however, that it had a molariform pattern with the talonid well developed. Five cusps are recognizable, three on the buccal aspect of the crown, two on the lingual aspect. Fortunately b–1 (protoconid) is preserved, and it is clear that the buccal convexity of that cusp was less than in the corresponding cusp of the first milk molar of modern man. The dimensions of the first lower milk molar of the Australian child are 9·5 × 7·5 mm., exactly the same as in the Carmel child, but the Australian crown is the higher—viz. 7·5 mm. The Carmel tooth has two roots, an anterior and labial, the other, posterior and lingual.

Both lower second milk molars (Fig. 139 E, Fig. 156 B) are preserved in the mandible and are intact. The hard crystalline enamel of the crowns is but slightly worn—there being a facet of wear on the trigonid and another on the talonid—most evident on the lingual aspect of the third outer cusp (b–3 or hypoconulid). The talonid is 0·5 mm. wider than the trigonid. The dimensions of the crown of the Australian second milk molar are 12 mm. (m–d) × 10·3 mm. (l–l)—compared to 10·9 × 9·3 mm. in the Carmel tooth. Although the cusp pattern is essentially the same in the Carmel and Australian molars, yet in the latter the enamel is thrown into folds, parts of which have been detached as conules, whereas there is very little secondary folding on the cusps of the Carmel molar. The drawing (Fig. 139 E) of the Carmel occlusal surface will suffice to show the cusp pattern (also Pl. XXII D). The anterior fovea is cut off chiefly by a ridge which emerges from b–1 ; a minor ridge from l–1 meets it, and thus completes the boundary of the anterior fovea. The chief ridge from l–1 descends into the cup of the talonid, to effect a union with the base of b–2. The posterior fovea, situated on the postero-lingual angle of the crown, is small and sharply cut off from the cup of the talonid by the chief ridge of b–3 and the minor posterior ridge of l–2. The latter cusp sends altogether three ridges towards the floor of the talonid cup. The apices of the lingual cusps rise to 2 mm. above the floor of the talonid cup. Cusp b–3 (hypoconulid) equals in size the cusp which lies in front of it. On the buccal aspect of the crown are seen the intercusp fissures ending below in small triangular depressions. The posterior fovea in the Australian molar is three times the size of the Carmel fovea, while the anterior fovea, also larger, is bounded posteriorly by the hinder oblique ridge which descends from l–1.

Permanent Dentition

The crowns of the four first permanent molars (Fig. 139 D, F) are available—the lower two preserved within the lower jaw, the two upper found in the upper level of the block of breccia. The upper crowns are completely formed, down to the neck. The dimensions, which are not remarkable, are given in Table LXVIII (p. 212). In Fig. 139 D the occlusal surface of the right upper molar is shown (also Pl. XIV, 9). The features which deserve mention are: (1) all four cusps are present, l–2 (hypocone) being as large as l–1 (protocone); (2) the oblique ridge which joins l–1 to b–2 has its anterior aspect sloping into the cup of the trigonid, while its posterior aspect is steep, bounding the anterior aspect of

the oblique fissure formed by the hypocone and the posterior marginal ridge, which is slightly crenulated and lies 2 mm. below the level of cusps l–2 and b–2; (3) the anterior fovea is situated between the crenulated anterior marginal ridge and a ridge joining l–1 and b–1, the ridge from b–1 springing from a distinctly marked protoconule; (4) the Carabelli fossa on the antero-internal aspect of l–1 (protocone) is of the swallow-nest pattern. The paracone (b–1) is really triple in its constitution, anterior, median and posterior cuspules being recognizable.

The alveolus over the right first lower molar was removed, thus exposing the pattern of the crown. The dimensions of the crown are given in Table LXVIII (p. 212) while the cusp pattern is shown in Fig. 139 F. The dimensions of the crown are large, but not exceptionally so. The greatest width is in the hinder (talonid) part of the tooth. The cusp arrangement conforms to Dr. Gregory's Dryopithecus pattern. The tips of the two anterior cusps are only 4·5 mm. apart; they are joined by a low sharp ridge which demarcates a rather ample anterior fovea. Of the three cusps of the talonid, the hinder, b–3 (hypoconulid) is the largest; l–2 and b–2 are of about equal size. The posterior fovea is represented by a narrow elongated fissure (oblique) bounded by the median ridge of b–3 and l–2. In the floor of the talonid cup are to be seen (1) a conule adjacent to the base of l–1; (2) two ridges on l–2 descend to it; (3) a separate conule lies at the apex of b–2. The buccal cusps are conical, separated by shallow grooves. The posterior fovea is on the postero-internal angle of the crown. In form and arrangement the cusps on the first lower permanent Carmel molar have many close resemblances to those of the second milk molar of the Australian child. Also it is important to observe that the lower first permanent molar repeats the cusp pattern seen in the second milk molar.

Upper Median Incisor (*Right*) (Pl. XIV, 3; Fig. 137 B).

Almost the entire crown has been formed. Its features are: (1) its width (10·9 mm.); (2) its relatively low labio-lingual diameter; (3) its protuberant swelling at the lingual base of crown; (4) the lowness of the crown compared to the width; its bevelled lingual surface. While the crown is 10·9 mm. wide at its cutting margin, it is only 9 mm. in its vertical extent. (5) The lingual surface is concave in both transverse and vertical directions. On the cutting-edge is a series of four tubercles, two of these being further subdivided; this edge slopes towards the distal (interdental) margin of the crown, which is raised. The medial margin, on the other hand, is rounded, until the cutting edge is almost reached, when it becomes raised.

Upper Lateral Incisor (*Right*) (Pl. XIV, 4; Fig. 137 D).

Only the crown is formed. Like the crown of i–1 the width is great in comparison with length as measured on the buccal surface. The height is 7·3 mm. The lingual tubercle, part of which has been broken away, was prominent and marked by secondary folds. The lingual surface is hollowed or spoon-like, bounded by a raised lateral margin and rounded medial margin. The cutting-edge is divided into two parts by a deep indentation or fissure, the medial part being marked by a conule, while on the lateral part are two conules. The cutting-edge descends gradually into the lateral margin of the lingual cup. The incisure on the cutting edge is a manifestation of the general tendency for the enamel elements to assume a separate development.

Upper Permanent Canine (*Left*) (Pl. XIV, 5; Fig. 137 E).

The crown had not quite completed its development. Its dimensions, which are small, are given in Table LXVIII (p. 212), and its lingual aspect will be seen in Fig. 137 E. When viewed on its buccal aspect the crown is seen to end in a peaked edge, with a median point or tubercle; at the medial end of the edge is another point or cusp, situated at the extremity of the straight median border of the crown, while a third marginal tubercle is developed on the cutting edge, at the termination of the short rounded distal border of the crown. On the lingual aspect of the crown are to be noted the lingual or basal tubercle, almost assuming a cusp form. The medial and lateral borders are raised and unite the basal tubercle to the cutting edge. Like the lateral upper incisor, the lingual surface is concave. The canine tends to assume an incisor form in its buccal aspect and a premolar form in the prominence of its lingual tubercle. The buccal cusp rises only 4 mm. above the level of the lingual tubercle.

We have surveyed the dental characters of the Carmel child because so little is known of the milk teeth of Neanderthal children and because the crown patterns are so well preserved in both milk and permanent teeth. On the whole, the characters of the teeth are those of the Neanderthal species, yet there are others which are peculiar to the Palestinian dentition, or have a resemblance to the teeth of modern man. There are features which we may regard as primitive, such as the molar pattern, but there are also others which are degenerative—such marks as have been noted in the incisor and canine teeth. Indeed the canine teeth of Neanderthal man are less simian than those of modern man.

Of the Neanderthal children there are only two with which to compare the dentition of the Carmel child—Dr. Martin's La Quina girl (aged 8 years) and the Gibraltar child (aged 4–5 years). In neither of these are the milk incisors or canines available, but there are the milk molars. Dr. Martin describes the upper first milk molar as having roots which did not embrace the developing crown of Pm–1; in the Carmel child the roots are wide apart. He describes a prominent Carabelli cusp on the upper second milk molar; in the Carmel child this is represented by a fossa or pocket. There are numerous minor differences between the La Quina and Carmel children in the cusp arrangement of the upper permanent incisor.

The Mandible

It will be remembered that the first trace of the Carmel child to be found was the fragment of the left side of the mandible shown in Figs. 155, 156, 218, also in Plates XVI F, XXII D, XXIII K, L. The fragment had the second milk molar *in situ*; it was not the excavator's pick which had broken the jaw just in front of the socket, for the fractured surface was coated with lime salts. The alveoli for the unerupted M–1 and M–2 were intact; the crown of M–1 was formed.

Behind was preserved a large part of the ascending ramus, including the coronoid process almost to its tip; the angle, the condylar process and posterior part of the ascending ramus were missing. The length of the fragment, measured along the middle of its outer surface, is 42 mm., 14 mm. lying over the masseteric impression. The next trace found of the Carmel child was part of the right half of the mandible; the ascending ramus had been broken away, the fracture occurring just behind the alveolus containing the crown of the first permanent molar. This fragment carried three teeth of the milk set,

the two milk molars and canine, while anteriorly it was continued by the alveolar border carrying the sockets of four lower incisors; the left lower incisor (milk), although damaged, was still in place. The region of the chin with the areas of muscular attachment unfortunately was missing. Nevertheless it was possible to effect a reconstruction of the jaw, for the only part of the alveolar border missing was that which carried the left canine and left first milk molar. The part missing on the left was copied from the right fragment and thus the reconstruction shown in Figs. 155, 156, 218 was obtained.

The occlusal aspect of the reconstructed mandible is shown in Fig. 156. There is only one Neanderthal specimen available for a comparison; that of the Gibraltar child which it is inferred was at least a year older than the Carmel child—whose age we place at 4 to $4\frac{1}{2}$ years. The degree in which the Gibraltar and Carmel mandibles correspond and the points in which they differ from mandibles of modern (Neanthropic) children are at once evident (Figs. 156 A, B, C, 218).

The antero-posterior diameter of the dental arch of the Carmel mandible (Table LXXXIII, note *, p. 322) is 26 mm., the same as in the Gibraltar specimen. In this measurement they agree with those taken in Neanthropic mandibles, but when we compare the width, taken between the outer margins of the second pair of milk molars, a remarkable difference is found. The bimolar width in the Carmel and Gibraltar mandibles is almost the same, 53 mm. and 54 mm.—8 mm. more than is usual in Neanthropic mandibles. In the Carmel child the width represents 203 per cent of the length, while in the Negro child the proportion is only 177 per cent. It is remarkable that the bicanine width is only little more than in Neanthropic children (Table LXXXIII, p. 322). We have already seen that the canine development in the Carmel child was less than in the Australian child. The great width and relative shortness of the mandibular dentition is not a simian feature but the opposite; it is ultra-human. The lower incisors were not proclivous but vertical, and the prognathism must have been less than in an average Negro child.

The close correspondence of the Carmel and Gibraltar mandibles is brought out in Fig. 156. The difference between the Carmel and Neanthropic profiles is illustrated in Fig. 218 where the Carmel mandibular profile is compared with that of a Negro child of about the same age. In the latter diagram an attempt has been made to complete the Carmel ramus, based chiefly on a comparison with the Gibraltar ramus. In Fig. 155 it will be seen that the anterior border of the ascending ramus of the Carmel and Gibraltar correspond in form; they begin to rise at the same distance behind the last milk molar, but that of the Carmel child ascends at a more acute angle. In Fig. 217 it will be seen that the anterior border of the ascending ramus of the Negro mandible is situated in front of that of the Carmel specimen and ascends at a steeper angle. On the other hand the body of the Gibraltar mandible, at the site of the second milk molar, is deeper than the Carmel mandible by 3 mm. (Table LXXXIII, p. 322). The striking feature of the Carmel mandible is the impression on the ascending ramus for the masseteric muscle. The lower border of the ramus expands suddenly downwards with a rounded everted margin. The masseteric impression forms a shallow concavity, save in its middle area where a thickening or ridge-like elevation marks the lower termination of the condylar buttress (Fig. 218 *b*). The ascending ramus is strong and thick, measuring 5 mm. at the condylar buttress. The minimum width of the ascending ramus we estimate

to have been about 26 mm., 2 mm. less than in the Gibraltar child. This measurement may be exceeded by modern children of native races.

On the lingual aspect of the mandible of Skhūl I we note the extremely strong ridge or eminence which continues the inner alveolar border backwards and upwards on the ascending ramus, above the opening for the dental canal. It is the inner expression of the condylar buttress. The area for insertion of the internal pterygoid forms a deep and extensive concavity. The mandibular canal has an opening about 4·7 mm. at its widest part. The canal is exposed on the right side on the fractured surface below the unerupted first molar, where it lies 3 mm. above the lower border of the ramus and has a diameter of 1·5 mm. The mental foramen is situated below the interval between the first and second milk molars; it is 11 mm. below the upper and 7 mm. above the lower border of the corpus. The opening is of a long oval form with an incipient septum between the anterior and posterior parts.

In Fig. 218 the position of the mandibular foramen is indicated on the outer aspect of the ascending ramus. The foramen is situated 19 mm. behind the anterior border of the ramus in the Negro child but only 13 mm. in Skhūl I. In the process of growth the anterior border of the ramus is absorbed and therefore recedes. The absorption and recession is greater in the Carmel child than in the Negro. Thus, even in early childhood, the Skhūl people exhibit Palaeoanthropic mandibular characters.

The Skull

Frontal Bone.

Up to this point (1) we have described the position in which the skeletal remains of the Carmel child were found; (2) the number of bones has been enumerated and their condition described; (3) the dentition has been discussed; (4) the mandible has been dealt with. There still remains one other important fragment to be described before we can discuss the cranial characters of the child—namely, the frontal bone. This, it will be remembered, was found apart from the skull (Figs. 214, 215, 216), having been detached in the disturbance done to the skeleton sometime after death.

The frontal bone has been damaged and broken (Fig. 217 A). Fortunately the upper part of its coronal margin, the part which comes in contact with the parietals in the region of the bregma, is intact. So is the marginal area of the parietals which correspond to this point. It is thus possible to articulate the frontal with the parietals and so complete the arch of the cranial vault. But as the marginal parts of the frontal and parietal, which should meet along the lateral parts of the coronal suture, have been broken away (Fig. 219 and Pl. XXII), a doubt arises as to the exact angle at which the frontal should be poised in relationship to the parieto-occipital fragment. The angle finally adopted is shown in Figs. 219, 221. The maximum length of the skull is 167 mm. and the maximum width 121 mm., the width being 72·4 per cent of the length, the skull being in the dolichocephalic class.

The frontal bone will be seen to be cracked and fissured in every direction, due we suppose to earth pressure. Besides such natural accidents the bone had also been the subject of violence soon after burial—or perhaps before—but whether deliberately or accidentally done, we cannot now decide. Ascending on the mid-line of the forehead there is a comminuted, slightly depressed area, 30 mm. long and 13 mm. wide (Fig. 217).

It ceases just where the forehead bends backwards into the vault, while below this area is seen to end in a gap 17 mm. wide between the inner ends of the right and left supra-orbital margins. The blow which caused the depressed area evidently drove the glabellar region and nasal root right within the skull. The fractured surfaces are coated by incrustation of calcareous salts, but the broken margin on the right side of the gap apparently bears the impress of a blunt-edged tool, while the opposite, or left margin, is undercut, showing that the force acted from without inwards. The thickness of the bone at the glabellar gap is fully 3 mm. That this fracture had been produced while the bone was fresh one infers from the fact that the bone on one side of the gap—the bone over the inner part of the right orbit—has 'sprung' or been lifted forwards its own thickness, in front of the level of the bone over the left orbit. The left half of the frontal is almost complete and apparently retains its original form.

As will be seen from Fig. 217, parts are missing at both ends of the eyebrow region of the right side, but on the left the supra-orbital margin is almost intact, lacking only a millimetre or two at the outer end. On the left side, too, the temporal line is preserved so that it is possible to estimate the minimum frontal width by doubling the diameter of the left half, which measures 42 mm. This minimum frontal width of 84 mm. (Table LXXIV, p. 296) is identical with that in the skull of a Negro child at exactly the same stage of dental development.

We have found that in modern women the minimum frontal diameter increases about 13 mm. after the fourth year. An increase of this amount would give Skhūl I an adult diameter of 97 mm., which is the same or very close to this measurement in Galilee, Tabūn I, Skhūl V, and Skhūl IX. The coronal margin is also preserved on the left side at the point of greatest frontal width, which in this case is 100 mm., about the same as in the Negro child. In the adult we expect an addition of 15 mm., which would give a maximum width of 115 mm.; in the Galilee skull the maximum frontal width was 113 mm., and in Skhūl V it is 114 mm.

We have no doubt that the forehead of the Carmel child represents the infantile stage of the type of forehead found in the Skhūl and Galilee men. The Carmel forehead is modelled differently from that of a modern child (Fig. 217 A, B). One notes that the frontal eminences do not form rounded bosses, or fuse into a single medial boss as in Negro skulls, but form oval eminences set well apart, so that the upper forehead looks wide. Below the eminences a wide shallow groove passes transversely, from near the mid-line, to end in the lateral temporal region of the frontal. Below this transverse frontal groove, and 11 mm. above the orbital margin, the frontal begins to shelve forwards, passing down to end in a sharp supra-orbital margin, which is more horizontal and wider than in a modern child.

The medial (supraciliary) as well as the lateral (supra-orbital) elements of the supra-orbital torus are already recognizable. These elements have characters never met with in Neanthropic children.

Another point is worthy of note. In the Galilee frontal the area adjoining the bregma is raised above the neighbouring level; this is also to be noted in the bregmatic area of the Carmel frontal.

The parts missing from the coronal margins of the frontal will be seen from the profiles of the skull reproduced in Figs. 219, 221. It will also be seen from Fig. 226 (vertex view)

that the frontal bone is warped so that the left half lies behind the right half. Further, it will be noted that along the course of the coronal suture of the left side there are gaps in the adjacent parts of the frontal and parietal. These were evidently produced by a single blow when the frontal and parietal were in articulation.

Although the glabellar and interorbital regions are missing from the frontal, enough remains to permit a reconstruction of the missing part in plasticine. The width of the interorbital process (bi-lachrymal) was about 22 mm.; in the Negro skull used for comparison this measurement is 21 mm. It is also possible to estimate the extent of the median frontal arc from nasion to bregma; this is 112 mm., while the chord of the arc is 98 mm. (Table LXXVI, p. 296). In the Negro child the frontal arc measures 114 mm., the chord 101 mm., being less flexed than in Skhūl I. The subtense is the same in both, 27 mm. An Australian infant, although younger than Skhūl I, yet has a skull of very similar dimensions to the Carmel skull. In this Australian the frontal arc is 112 mm., the chord being 93 mm., the curvature being greater than in the Carmel child. In the Australian frontal the highest point of the arc rises 24·5 mm. above the frontal chord. In the Galilee frontal the arc measured 125 mm., the chord 113 mm., while the height of the arch was 17 mm. As is well known, the curvature of the frontal becomes altered after childhood, both in modern and extinct races of mankind. The frontal angle, measured as reconstructed in Fig. 219, is 90°, against 60–67° in the adult Skhūl crania. In the Negro skull (Fig. 220) the angle is 100° owing to the bulge forward of the frontal eminences. The tabular part of the frontal in Skhūl I has a thickness varying between 2 and 3 mm.

Parietal Bones.

Both parietals are intact along the sagittal suture from bregma to lambda. The form of serration seen in this suture is depicted in Fig. 226 (vertex), but the closeness and fineness of the sutural line and the minute spicular secondary serrations are hard to represent. The same four regions can be recognized in the sagittal suture of Neanthropic skulls. In the region of the bregma the bone is raised. There is no sagittal keeling. The median parietal arc measures 114 mm.; the chord from bregma to lambda 107 mm.; the highest point of the arch rises 20 mm. above the chord. The highest point with the skull in the Frankfort plane lies 35 mm. behind the bregma. In Table LXXVI (p. 296) are given the parietal measurements of the Negro child; they are very similar to the Carmel ones, the highest point lying 32 mm. behind the bregma. In the skull of the Australian child the parietal arc measures 120 mm.; the chord 106 mm.; height of arch 20 mm. The parietal arches of the Carmel and Australian skulls differ; the Carmel arch is evenly curved; the Australian is flattened in its posterior two-fifths. On the other hand, the curvature of the parietal is not greatly different from that of the Negro child.

The hinder or lambdoid borders of both parietal bones of the Carmel skull are almost intact (Fig. 225). As will be seen in various drawings, the sutural pattern is complex, having narrow scalloped digitations which embrace those of the occipital to a depth varying from 7 to 9 mm. The length of the lambdoid suture (from lambda to asterion) is 99 mm. on the right, and 98 mm. on the left. The left parietal is broken at the region of the asterion. The chord of the right suture measures 88 mm., of the left 87 mm. The height of the arch is 18 mm. We have made corresponding measurements on the Negro

and on the Australian child's skull, the result being to show that the lambdoid suture of the Skhūl child is longer and more curved than in the modern skulls with which we compared it. Thus in all dimensions the hinder borders of the Carmel parietals exceed the Australian or Negro measurements. Further, the pattern of the lambdoid suture of the Australian skull is very simple; that of the Negro is moderately complex; that of the Carmel child very complex.

As to the anterior or coronal borders of the parietal bones, the left is intact for 25 mm. from the bregma; thereafter the border is broken; the gap caused by a blow near the middle of the suture has been already mentioned, while the anterior inferior angle has been broken away. The amount missing is shown in Figs. 219, 221. On the interior of the left parietal are preserved the ramifications of the middle meningeal vessels. It is impossible to give an exact estimate of the length of the anterior (coronal) border of the parietals, but it must have been about 105 mm. In the Australian child's skull the coronal border measures 107 mm.; on the right side Tabūn I gives a measurement of 115 mm.; the measurement in the Negro skull is similar. A feature of the Carmel skull is that the posterior border of the parietal bone measures about the same as the anterior.

As to the lower or squamous border of the parietal, there are three parts: mastoid, temporal, and sphenoid. On the left side, the side on which the skull lay, the temporal bone (save part of the petrous) is missing, and so is all the lower border of the left parietal, the deficiencies being at its anterior (pteric) and posterior (asteric) angles. Just at one point in the lower border of the left parietal is there an indication of the squamous suture; at this point the parietal bone measures 120 mm. from the lower to the upper (sagittal) border. At the same point the Australian child's parietal measures 118 mm. The parietal suture was not bevelled but in apposition.

On the right side (Fig. 221) the lower border of the parietal is intact along the whole of its mastoid articulation, 25 mm. in extent, a somewhat complicated junction; it is also complete along the greater part of the squamous (temporal) union. This part of the border measures 32 mm.; on the surface it appears as a fine slightly wavy suture, but at the fractured edge in front it is seen to be somewhat bevelled, the contact being direct and flat. The great wing of the sphenoid and all the parts of the parietal which lay above the sphenoid are missing, but one infers that the lower border of the parietal when measured in a direct line from pterion to asterion was about 80 mm. In the Australian child's skull this distance is 80 mm. One notes, however, that the lower (squamosal) border of the parietal was remarkably straight; there was not a big squamous concavity as in modern skulls (Figs. 219, 220, 221). When the Carmel squamosal is superimposed on that of the Negro (Fig. 220), it is seen to be of smaller area, but when the parietals are superimposed the case is reversed; the Skhūl child's bones being the more extensive vertically.

So far we have been enumerating the dimensions and proportions of the two parietal bones. One point elicited is that the lambdoid and squamosal margins are, when compared with the sagittal, relatively long. For example, the chord of the squamosal border must have formed at least 78·4 per cent. of the chord of the sagittal arc, whereas in the skull of the Australian child this proportion is 74·5 per cent. The lower or squamosal border was relatively straight when compared with that of Neanthropic skulls. There are other striking features of the Carmel parietals, the most noticeable being the distinct and

extensive development of the parietal eminence, a feature in which the Skhūl type differs altogether from the Neanderthal type of Europe. In the latter type the parietal eminence, as in the skulls of anthropoid apes, is lost in the general parietal outline.

The occipital view of the child's skull (Fig. 225; Pl. XXII B) brings out this feature of the Palestinian skull. In Skhūl I the centre of the parietal eminence is 63 mm. from the sagittal suture, 56 mm. from the lambdoidal, about 60 mm. from the coronal, and 48 mm. from the squamous margin. Another feature of the parietal is the presence of a wide shallow groove which, beginning over the lower fourth of the lambdoidal suture, passes forwards below the parietal eminence and above the squamous suture, apparently ending in front over the region of the pterion and the Sylvian fissure. Behind, this groove is continued along the occipital bone, ending above the inion. It corresponds behind with the depression which separates cerebrum from cerebellum. We propose to name this the lateral cranial groove. We shall see that it is an external expression of the arrangement of the cerebellar hemispheres and temporal lobes. Just at the anterior end of the right cranial groove a small area of bone is depressed and fractured by the pressure of an overlying stone. As the natural endocranial cast was also compressed at the point, we infer that this injury occurred before the cavity of the skull had become filled with a concretion. The parietal bone varies in thickness from 1 mm. near lower border to 4 mm. behind the parietal eminence. The prevailing measurement would be 2 mm. On the interior of the bone are grooves for the meningeal vessels and longitudinal sinus; these, with the cerebral markings, will be discussed in connexion with the endocranial cast in Chapter XXI.

Occipital Bone.

It is a most fortunate circumstance that this bone is almost complete and such degree of distortion as is present can be estimated and allowed for. The only part missing is the basi-occipital and that part of the left ex-occipital which carries the occipital condyle. With these exceptions the bone is complete. This, as we have said, is fortunate, for one of us in reconstructing the missing hinder part of the Galilee skull, being impressed by the Neanderthal features of its frontal, malar, and sphenoid, inferred that the parietal and occipital bones of the Palestinian type of Neanderthal man must be modelled as in the Neanderthal skulls of Europe. We have just seen that the Carmel parietals have peculiar features, which are of a Neanthropic rather than of a Neanderthal character.

It will be best to deal first with the region of the foramen magnum (Fig. 223). It will be seen that the margin of the foramen magnum is present on the right side from the middle of the condyle to the opisthion; the length of this margin is 35 mm., 23 of which lie behind the damaged condyle. On the left side the margin is preserved for 17 mm., measured from the opisthion. That part of the left ex-occipital which bounds the foramen magnum, as the result of long continued pressure against a stone or some resistant object, has become depressed within the skull to an extent of 4 mm., thus distorting the cavity which contains the left hemisphere of the cerebellum (Fig. 225). This depressed area is 17 mm. wide; it begins at the hinder margin of the foramen and involves the opisthion which is depressed to an extent of 2 mm. The depressed area is so firmly fixed by calcareous salts and so broken that we have not attempted to remedy the defect, seeing that on the right side the parts are intact and in their normal position. Thus the

part of the foramen magnum which is preserved intact measures 27 mm. in its median antero-posterior direction; if we allow 8 mm. for the part bounded by the missing basi-occipital we have an antero-posterior diameter of 35 mm. for the foramen magnum. Its width, estimated from the intact right half, was 26 mm.; these dimensions are in no way exceptional. In the Australian child's skull the foramen magnum measures 36 × 24 mm.; in the Negro child 36·5 × 25 mm. In the Australian child (under 2 years of age) the suture between ex-occipital and supra-occipital is widely open; in the Carmel child it is clearly traceable, its chord measuring 31 mm., the same as in the Australian skull, but in the Carmel skull the suture is more curved with its convexity directed posteriorly. The canal for the hypoglossal nerve is preserved in the right occipital condyle, showing that the two components of the condyle had not become united at the time of death.

The muscular markings on the nuchal part of the occipital are indicated in Fig. 223 A. The inion is indicated by a T-shaped ridge or elevation. The inial elevation is continued downwards as a median ridge between two deep and wide fossae for attachment of the complexus muscles. These are shown in our drawing (Fig. 223 *sc*). Above each complexal fossa is an elevation for the attachment of the splenius and trapezius. Below the complexal depressions the bone rises into transverse elevations, on which is a sharply marked impression for the rectus capitis posterior major (Fig. 223 A, rc^2). Below the lower transverse ridges the external median crest again becomes well marked with a depressed area on each side for the rectus capitis posterior minor (Fig. 223 A, rc^1). The impression for the superior oblique (*oc*) is also well marked. The distance from inion to opisthion is 29 mm.; the lower part of the median crest is 12 mm. long. The impressions on the nuchal or muscular part of the occipital are more sharply demarcated and differ in form from those seen on the skulls of modern children of like age.

The lateral nuchal aspect of the skull of a Negro child is compared with that of Skhūl I in Fig. 224. The Negro occiput is prolonged backwards and is pointed, whereas this region is short in the Carmel child and ends in a low and wide convexity. Above the site of the inion, but below the most projecting part of the occiput (Fig. 223 A), is an X-shaped groove or furrow which seems to be noteworthy, as it represents, or seems to correspond to, the supra-inial fossa seen on the occipitals of adult Neanderthalians (Fig. 186 B). The groove is formed between the upper and lower elements of the squama occipitalis, and is clearly differentiated in a radiograph (Pl. XXVII D). The slight fossa in the Negro skull (Fig. 223 B, x') appears to represent the X-shaped groove.

The sagittal arc of the occipital, from lambda to opisthion, measures 105 mm.; the supra-inial part measuring 76 mm., the infra-inial 29 mm. The chord of the arch is 87 mm.,[1] the subtense 28 mm. The corresponding measurements in the skull of the Australian child are: arc, 103 mm.; chord, 81·5 mm.; subtense, 25·5 mm.; while for the Negro child these are: arc, 101 mm.; chord, 83 mm.; subtense, 27 mm. A passing comparison of these measurements would lead to the conclusion that the occipital curvatures of the three bones were similar, whereas they are truly different (Fig. 224). In length of arch and in index of curvature there is no point which distinguishes the Carmel occipital from that of Neanthropic children. The short chord and acute occipital bending seen in Neanderthal occipitals are absent.

[1] The actual measurement is 84 mm., but 3 mm. have to be added on account of the upward displacement of the lower part of the bone.

Two features relating to the lower part of the occipital, the part which contains the lateral lobes of the cerebellum, require mention. The first is the great width of the Skhūl child's occipital in this region. The bi-asterionic diameter is 106 mm., whereas in the Negro skull it is 97 mm. The second is the fullness, the convexity, and the degree of separation of the cerebellar poles in the child's skull (Fig. 224 A, B). This is in marked contrast to the flatness of the lower nuchal region in the skulls of adult Neanderthalians of Europe.

It has already been mentioned that the transverse cranial groove is continued backwards on the occipital, lying between the cerebellar expansion below and the occipital pole above. The groove passes towards the inion, but fades out 20 mm. distant from that point. In the occipital bones of modern children this groove is usually clearly visible, but it passes below the level of the inion before reaching the midline.

The markings on the inner aspect of the occipital bone are extremely well preserved and are best studied on the endocranial cast (Figs. 240, 244). The fossa for the left occipital pole is by far the more extensive; it projects rather more backwards (is deeper) than the right fossa, indicating a specialization of the right hand (Elliot Smith). Between the two fossae is a wide low ridge, rounded in transverse section, which begins at the internal lambda, where it is about 10 mm. wide, and ends below, at the site of the internal inion, as an elevation over 15 mm. wide. On the lowest part of this elevation begins the impression of the longitudinal sinus which turns to the right to form the right lateral sinus. Otherwise the internal median occipital ridge is not grooved; the groove for the longitudinal sinus on the parietals ceases just as the lambda is reached. The right lateral sinus has a width of 8·5 mm. There is no groove for the left lateral sinus; between the fossa for the left occipital pole and the deep fossa for the left lobe of the cerebellum there is a transverse ridge, triangular in section and 3·5 mm. in height. The groove for the right lateral sinus has at first a high ridge above it and then as it approaches the region of the asterion is ridged on both sides, but the upper is always the more prominent. The lateral sinus grooves the posterior inferior angle of the parietal for a distance of 12 mm. Thereafter it passes on to the mastoid.

One notices a difference in the manner by which the occipital fossa is separated from the cerebellar on the right and left sides. On the right side the prominent ridge which separates the fossae is situated at the upper border of the lateral sinus, whereas the ridge on the left side is situated at a lower level, one which would correspond to the lower border of the lateral sinus on the right side.

Another point worthy of attention is the relationship of the external inion (Fig. 224, *i'* and *i*) to the internal inion. In the crania of the adult Skhūl people, and as in Neanderthal crania of Europe, the external inion has ascended 10 mm. above the internal. The two are almost opposite each other in the Carmel child, but in the Negro child the external is still below the internal inion. As we shall see, the neck of the Skhūl child is stouter, is more advanced in its development, than in the Negro child. We shall find that this holds true of all the muscular processes of the Skhūl infant skull; the temporal muscle, as indicated by the temporal lines, is situated higher, and the fronto-malar process is stouter than in the Negro child.

Between the right and left cerebellar fossae is a sharp narrow median ridge, 5 mm. in height at its middle part. Below, some 12 mm. from the foramen magnum, this ridge

divides, each half passing into the lateral boundaries of the foramen. Above, the lower median ridge or crest expands into the diamond shape elevation in which, as we have seen, the upper median ridge between the occipital impressions also ends.

The cerebellar fossae are deeper than we have seen in any child's skull. The width of the right fossa measured between the mid-point of the lower border of the lateral sinus and the upper margin of the foramen magnum, at the post-condylar point, is 42 mm.; the depth of the fossa, measured in the plane joining these points, is 12 mm. The corresponding measurements made on the skull of an adult Tasmanian give a width of fossa of 39 mm.; its depth was 6 mm. Another measurement brings out the exceptional relationship of the cerebellar lobes to the occipital lobes. The cerebellar lobes at their widest points, measured on the endocranial cast, have a transverse diameter of 93 mm., the width of the occipital lobes measured where the lambdoidal suture crosses their lower borders is 100 mm. wide.

Temporal Bone.

It will be remembered that the skull rested with the left parietal eminence as its lowest part, while the right parietal eminence and right temporal bones were directed upwards and were the first to be exposed. While the right temporal is almost complete and in its normal articulation with surrounding bones, the left temporal was found detached and imperfect. The lowest part of the left parietal is missing, but on the occipital bone the suture for articulation with the mastoid is preserved (Fig. 221).

The peculiar outline of the Carmel temporal is seen in Figs. 219, 221. The Carmel temporal is really an intermediate type, combining characters of both Neanthropic and Neanderthal bones, and also showing certain specific peculiarities. In the chimpanzee and gorilla the upper border of the temporal bone, both mastoid and squamous parts, forms a continuous horizontal line almost parallel with the Frankfort plane. In human skulls of the Neanthropic type the mastoid and squamous parts of the upper temporal border are sharply delimited, the squamous rising arch-wise well above the Frankfort plane. In Neanderthal skulls the delimitation is less marked; the squamous margin rises gradually to the top of the arch without any sharp angle at the point of junction. This is so in the skull of the Palestinian child. The union is marked by fine serrations.

The differences between the infant Skhūl and a modern child's temporal bone is brought out in Fig. 220, where the Skhūl temporal has been superimposed on that of the Negro child. The Carmel squama falls short of the Negro by 8 mm. in height and 4 mm. in anterior development, and yet in their total dimensions, length, width, and height, the two crania are nearly similar. In the adult Skhūl crania the squamae tend to fall short of the modern, especially in their anterior development. In actual measurements the resemblances of the Carmel temporal are with modern children and yet the outline of the upper border is that seen in Neanderthal skulls.

We tried another method of comparing the post-auricular with the pre-auricular part of the temporal as seen in a true profile of the skull. In the Skhūl child, 38 mm. lies behind the porion, 28 mm. in front of it; in the Gibraltar child the corresponding measurements are 42 and 34 mm.; in the La Quina child, 45 and 29 mm.; in the Australian child, 40 and 30 mm.; in English children, 38 and 31 mm. It is clear from the proportions of these figures that the post-auricular part varies from 55 to 60 per cent. of the total length,

and that neither in absolute nor in relative dimensions do the ancient and modern types vary in a distinctive manner. The fact remains that the Skhūl child's temporal bone has most distinctive anatomical features.

The mastoid area of the Skhūl temporal is altogether peculiar in its form and position. This is due to the part it plays in forming the widely expanded floor of the cerebellar fossa. In the occipital view of the skull (Fig. 225) the mastoid presents little more than an edge; the mastoid area, including the process, follows the lateral contour of the skull, the process being appressed to the side.

The mastoid process, in other respects, is as well and strongly developed as in modern children of similar age, 4–4½ years. Its apex descends 17·5 mm. below the Frankfort plane, whereas in the Negro child the same measurement is 14 mm. (Fig. 224). On its outer aspect is a wide rough impression for the attachment of the sterno-mastoid, this impression ceasing at the masto-occipital suture, 8 mm. below the asterion. The bi-mastoid width, taken between the bases of the mastoids, is 104 mm., 4 mm. more than in the Negro child. The bi-apical diameter is estimated to have been 88 mm. as against 86 mm. in the Negro skull. Just behind the mastoid the bone is somewhat damaged in the fossil skull, but it is clear that the digastric fossa had the form of the groove seen in Neanthropic skulls. At the inner border of the digastric fossa is the groove for the occipital artery. The apex of the mastoid descends 3 mm. below the inner border of the digastric impression, whereas in Tabūn I, as in Neanderthal skulls, the opposite is the case.

One other peculiar feature of the Carmel temporal must be mentioned, namely, a wide shallow depression, like a thumb-impress, above the auditory meatus and in front of the mastoid element. This, in reality, is a consequence of the lateral prominence of the mastoid process.

The Ear, Tympanic Plate, and Temporo-mandibular Joint.

Some of the features which best serve in the discrimination of Neanderthal from modern races of mankind are found in the region of the external auditory meatus. In Neanderthal skulls the auditory meatus has a rounded or oval aperture, with the long axis in an antero-posterior plane, the tympanic plate is horizontal and the temporo-mandibular joint is not divided, as in modern man, into a deep depression behind an articular eminence. Unfortunately, an injury done to the Carmel skull, long before its cavity had become filled with calcareous deposit, makes the task of deciphering the characters of the auditory region difficult. The nature of the injury will be seen in Figs. 219, 224. The skull, as we have seen, lay in the grave with the right ear upwards. When lying in this position an implement, which made an opening 15 mm. × 7 mm., had been thrust into the skull, carrying in front of it the post-glenoid spine, part of the floor of the joint, and part of the roof and anterior wall of the external auditory meatus. In this way the root of the zygomatic process was destroyed and detached, while the inner part of the squamous process was detached and displaced slightly inwards. Fortunately the greater part of the tympanic plate escaped; the tympanic foramen, with a diameter of 3·5 mm., is still open, separating the anterior from the posterior processes. Internally the plate ends at the opening for the internal carotid which has a diameter of 5 mm. The length of the tympanic plate from carotid foramen to the outer rough margin in front of the mastoid is 17 mm. In modern man the lower margin of the tympanic plate is a mere

edge forming the lower or posterior border of the vaginal process, whereas in Neanderthal the lower surface of the tympanic plate is divided into anterior and posterior areas by a vaginal ridge of peculiar form. In the size and shape of the posterior area of the tympanic plate, the Carmel child on the whole resembled modern rather than Neanderthal man. Behind the plate and internal to the mastoid process are the openings for the facial nerve and the minute hole for the styloid process (Fig. 223 A). Part of the anterior process of the tympanic plate is missing, but its length from the opening of the Eustachian tube to the site of the post-glenoid spine would have been about 18 mm. In its form, size, and stage of development the Carmel tympanic plate differs from that seen in the temporal bones of the La Quina and Gibraltar children, and has a close resemblance in all points to that seen in the Negro child's tympanic region.

The auditory meatus was round in form, with a diameter at the site of attachment to the tympanic membrane of 9 mm., rather larger than in modern children. As in modern children the roof of the external meatus, between the post-glenoid process in front and the base of the mastoid behind and external to the attachment of the drum, forms a funnel-shaped surface. This part of the auditory roof of the Carmel child shows two pits, an outer, such as would take the point of a lead pencil, and an inner, which is deeper and wider, and seems to lead into diploe. Concerning the nature of these pits, we are uncertain as to whether they are structural or artificial, the latter being more probable in that we have not met with similar formations in other skulls. Dr. Martin mentions a minute fossa in the roof of the meatus of the La Quina child. There is only a faint indication of a post-meatal spine.

We were able to clear out the matrix from the interior of the tympanum and thus to expose the inner or medial wall of the cavity. As this cavity has not been seen before in comparable material we propose to give a somewhat detailed description of the inner wall (Fig. 219).

In the centre of the inner wall is situated the promontory, rounded in outline and with a diameter of 7·5 mm. Above the promontory is seen the fenestra ovalis, the long diameter of which is 3·4 mm. Above this fenestra is exposed the canal for the Seventh (Facial) nerve for a distance of 6 mm. Behind and below the promontory is the fenestra rotunda. Opening from the posterior wall above and behind the fenestra ovalis, i.e. from the 'attic' of the tympanum, is the opening of the antrum for the mastoid. This measures about 4×4 mm. It is a shallow recess with a depth of about 3 mm.

In the roof of the tympanum above the canal for the Seventh nerve opens the 'attic'. This cavity has a depth of about 6 mm. and measured in the transverse plane a width of about the same dimensions.

Turning to the inner aspects of the skull we draw attention to the following features of the anterior and posterior surfaces of the petrous bone. First, on the posterior aspect, behind a raised boundary between the two surfaces of the petrous, is the internal auditory meatus which is oval in shape, measuring 5×4 mm. Second, about 10 mm. lateral to the internal auditory meatus there is a slight depression indicating the position of the hiatus vestibuli. We note also that the superior semicircular canal is not sharply demarcated on this aspect of the bone. There is, consequently, no clear trace of the vermian fossa which is so evident in the lower apes.

The upper border of the petrous pyramid is rounded and not sharp and ridge-

like. Along this border we can detect no trace of the groove for the superior petrosal sinus.

Of the left petrous bone we have the following parts, namely, from just medial to the internal auditory meatus to the lateral (outer) wall of the tympanum. Thus the apical part of the petrous bone is broken away, exposing the canal for the internal carotid artery and also the orifice for the aqueductus cochlea. The latter is a funnel-shaped opening measuring 4×2·5 mm. The inner wall of the tympanum is completely exposed, the features of this wall reproducing exactly those described on the right side. We note also that the external semicircular canal is exposed on the fractured mastoid surface. On this surface there is a smooth area, triangular in shape, measuring 7×4 mm. This clearly is the inner wall of the antrum of the mastoid.

The following parts of the floor of the tympanum are present: first, that part of the tympanic plate which lies in front of the tympanic foramen. The outer end of the plate terminates in a rough margin for the attachment of the cartilage of the ear, while the inner margin is pointed, bounding the opening of the tympanic canal (Eustachian tube). We note also that at its medial end this part of the plate enters into the formation of the canal for the internal carotid artery. The length of this part of the tympanic plate from its outer to its inner margin is 19·5 mm. There is also preserved that part of the wall of the tympanum which forms the vaginal ridge.

It is to be noted that the lower margin of the vaginal process is not sharp and rough as in the infantile stage of *Homo sapiens*, but is blunt and smooth. Nevertheless, the vaginal ridge did not divide the tympanic plate into anterior and posterior moieties, as in the Gibraltar skull, but as in modern children was placed on the hinder border of the plate.

The oval foramen in the tympanic plate measures about 6·5 mm. (long axis). Whether the foramen was completely enclosed or remained open, as would result from a non-union of the processes, cannot now be determined. On both sides, the posterior margin of the vaginal plate is rounded and smooth.

Unfortunately, the injury to the region of the mandibular fossa makes a description of it impossible. One can see, however, that the fossa was not deep and that the articular eminence formed a plateau, which measured at least 18 mm. from before backwards and at least as much from side to side.

Thus the characters of the Carmel temporal are altogether peculiar, differing from those of Neanderthal and modern man, but conforming more to the modern than to the Neanderthal type.

The Skull in Profile.

In Fig. 221 is shown an exact tracing of the right side of the Carmel child's skull; this aspect is also represented in Pl. XXII A. In Fig. 219 we give a drawing of the Carmel skull, showing the left side, but in this aspect we have introduced features which were only preserved on the right side. The skull was orientated on the Frankfort plane, 29 mm. having been allowed for the height of the orbit. As thus reconstructed the skull has a length of 167 mm., a width of 121 mm., the latter being 72·4 per cent. of the former, a dolichocephalic skull. Knowing that a low vault is a characteristic of Neanderthal man, we turn to the height to which the vault of the child's skull rises above the Frankfort plane. The highest point, situated 35 mm. behind the bregma, rises to 104 mm. above

the plane; the bregma height is 101 mm.; the height of the lambda 62 mm. In the skull of a Negro child (Fig. 220) which has a length of 170 mm. and a width of 121 mm., the corresponding heights are 106·5, 103, and 54 mm.; in this Negro child the width is the same but the length and height are 3 mm. more. If we accept this Negro skull as representative of Neanthropic children, then the Carmel child in its length, breadth, and height, and in its contours, is also Neanthropic. Of the Neanderthal skulls which provide suitable comparisons, that of the La Quina child is best.

She was at least three years older than the Carmel child. The La Quina girl had a skull which was 171 mm. long, 132 mm. wide, giving a cephalic index of 77·2 mm. The highest point of vault, 108 mm., is situated 40 mm. behind the bregma. The bregma is only 97 mm. high, the lambda 81 mm., an exceptional measurement. In the Gibraltar boy the highest point rises 108 mm. above the Frankfort plane, but then the skull is 184 mm. long and 150 mm. wide; in the Gibraltar boy the height of vault is 58·7 per cent. of the cranial length; in the Carmel child it is relatively greater—namely 62·2 per cent. In the Negro child the height quotient is 62·6 per cent., but then in the La Quina child it is still greater, 63·1 per cent. Thus in the actual dimensions of the Carmel skull, length, width, and height, we obtain no diagnostic guidance; the measurements fall within the range of the variations found in both modern and Neanderthal skulls of children and yet we can definitely say it has not the low flat vault of typical Neanderthal skulls.

The basi-bregmatic height of the Skhūl child is estimated to have been 114 mm., which is 4 mm. more than in the Australian child's skull but 3 mm. less than in the Negro child, whose cranial measurements are otherwise similar to those of the ancient child (Tables LXXIII–LXXV, pp. 295–6). It will be observed that in the Skhūl child, as in the adult crania of the Skhūl people, the basi-bregmatic height is less than the greatest width of the skull.

When the Carmel child's skull is orientated on the Frankfort plane as in Fig. 219, it will be noted that the auditory meatus lies slightly anterior to the mid-point of the cranial length, 50·8 per cent. of the total length being post-auricular. In the Negro child's skull the post-auricular part forms 51·4 per cent. of the total length; in the Australian child's skull 54·2 per cent., in the La Quina skull 53 per cent. Here again actual and relative dimensions give no clue to racial identification.

It is otherwise when we view the profile of the skull as a whole. In no Neanderthal skull of Europe do the parietal, occipital, and mastoid parts of the profile make the circular sweep seen in this skull. In Neanderthal skulls the occiput is raised and undercut; in the Carmel skull it is the opposite. On the other hand, the outline of the temporal bone is such as is never met with in modern skulls, and in this respect the Carmel skull shows a distinct approach to the Neanderthal type.

Although we are of the opinion that the elaborate system of angles and indices worked out by Schwalbe and others to register the form of the vault will prove a hindrance rather than a help in laying a scientific basis for a knowledge of human races, for the benefit of those who use such systems we may consider the calotte height index in two skulls, that of the Skhūl child and of the Negro child. The glabello-inial length is 156 mm. in the Carmel child, the vault rising 95 mm. above this plane at its highest point. The index is 60·9. In the Negro child the length of the plane is 152 mm., the height 96 mm., the index 63·1. Both fall well within the upper range for modern adult skulls. Yet had this Carmel

child lived to adult years, the calotte height index might have fallen to the upper limit for Neanderthal crania, namely, an index of 45. Two changes in the glabello-inial plane come with growth. It is lengthened by the addition of bone to the supra-orbital and to the occipital torus. Also the plane moves up towards the vault owing to the growth ascent of both the tori. It is probable in the case of the Skhūl child that the growth changes would have resulted in a condition similar to those described in the Skhūl adults, where the mean index lies between 47 and 48.

Occipital Aspect.

In Fig. 225 is reproduced an exact drawing made of the occipital aspect when the Carmel skull was orientated on the Frankfort plane. It will be seen that the inion and external occipital crest falls 1–2 mm. to the right of the mid-sagittal plane as determined by the sagittal suture on the vault. This diversion of the conceptacula for the cerebellum to the right may be physiological, for it occurs in normal skulls, but in this case it is more likely to be due to earth pressure. It will be seen that the left parietal bone at its lower part, where it is defective, had lost the support of the temporal bone, and is deflected inwards some 6 or 8 mm. The occipital bone is intact, so far as the view presented in Fig. 225 is concerned. When the corresponding view of the skull of a Negro child is compared with the Carmel outline, the general resemblance is apparent; in both the parietal eminences are emphasized, and in both the sides of the skull are more or less vertical and flat. The chief difference lies in the great fullness, both downwards below the Frankfort plane, and outwards, away from the mid-sagittal plane. These peculiarities we have described in connexion with the occipital bone.

When we make a comparison with a corresponding view of the skull of the La Quina child, it is seen at once that the hinder region of the skull of the Carmel child is totally unlike that of the La Quina child. In the latter, parietal eminences, mastoids, and cerebellar conceptacula fade into a general rounded outline, as in the occiputs of young anthropoids; there is no need to devise indices or any mathematical device to bring out the differences. In the La Quina skull the occipital bone is set high in relationship to the Frankfort plane. In Neanderthal skulls there is an external depression between the poles of the occipital lobes; in the Carmel skull it is the cerebellar lobes which are set widely apart. In the hinder region of the skull, the Skhūl child resembles the modern rather than the Neanderthal child so far as we know this type in ancient children. It differs, however, from both modern and Neanderthal specimens in certain respects.

Vertex and Frontal Aspects of the Skull.

There remain two other views of the skull of the Skhūl child to be considered, the vertex (Fig. 226) and the frontal (Fig. 222), but as they add little to our knowledge they may be dismissed with brief descriptions. The vertex view, as seen in Fig. 226, is orientated on the Frankfort plane. Over this we have superimposed a tracing of the vertex aspect of the Negro child. The degree of correspondence is surprising: in the posterior half the Negro outline contracts more rapidly, the Negro occiput being more attenuated than in the blunt, wide Skhūl occipital. The greatest width in the Skhūl child lies just over the ears, being rather farther forward than in the Neanthropic skull. In the Carmel skull the parietal eminences pass gradually into the rounding of the occiput. No great

difference is apparent in the frontal region. The wide, pear-shaped hinder third of the skull, which is characteristic of Neanderthal man, is absent in the Skhūl cranium, but there is a suggestion of this fullness. The Carmel outline may be described as intermediate to those of Neanderthal and of modern man.

A frontal view of the Skhūl child's skull is reproduced in Fig. 222, where the relationships of the frontal bone to the other parts of the skull are made clear. In Fig. 217 we have sought to indicate the modelling of the forehead and the form of the supraorbital arches. Fig. 222, on the other hand, emphasizes again the fullness of the cerebellar conceptacula and the degree of prominence of the parietal eminences.

Summary.

No matter which series of characters we take into consideration, dental, mandibular, or cranial, the result is the same. In all of them we meet with a mixture of characters both Palaeoanthropic and Neanthropic. The basal characters are Palaeoanthropic; the modern features seem to be grafted on to this archaic foundation. The elements which give rise to the supraorbital torus of the adult are in their earliest stages of development, but even at this early stage the rudiments in the Skhūl child differ from those seen in the forehead of a modern child. The characters of the dentition are essentially Neanderthaloid.

The dentition corresponds in its stage of development to that seen in a modern child of 4–4½ years of age. In some respects the skull of this ancient child is more advanced in its development than we would expect to find in a modern child of similar age.

Table LXXXIII. THE JUVENILE MANDIBLE

	Skhūl I	*Gibraltar*	*Negro 4 years*	*English 5 years*
Palate length*	26·0	26·0	26·0	25·0
Width:				
between buccal margins of m-2	53·0	54·0	46·0	45·0
between lingual margins of m-2	35·0	33·0	26·5	27·0
bicanine	31·0	32·0	28·5	28·0
bicoronoid	74·0	82·0	77·0	77·0
bicondylar	90·0†	108·0	88·0	86·0
Body at m-2:				
height	16·0	19·0	18·0	18·0
thickness	12·0	15·0	12·8	13·0

* Measured from the anterior median incisor border to the mid-point of a line tangent to the distal borders of m-2.

† Estimated from the skull.

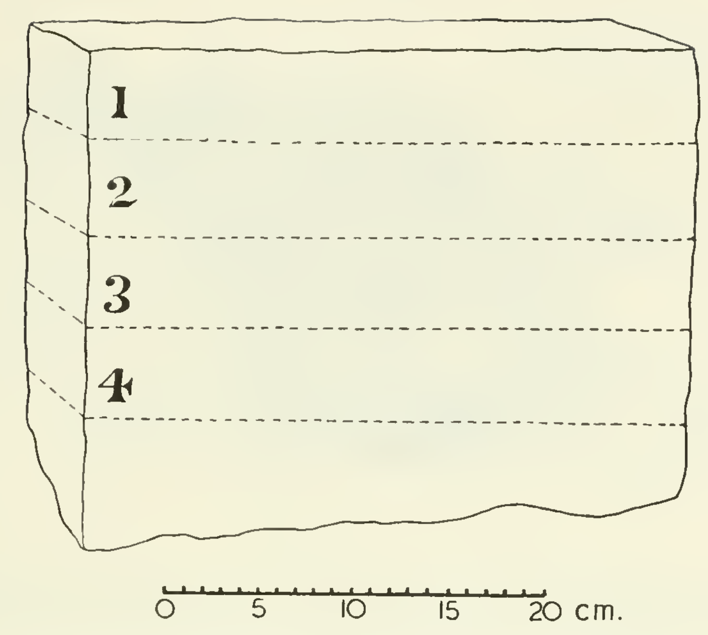


Fig. 213. A Three-dimensional Plan of the Block of Breccia Containing the Skull and Skeleton of Skhūl I, with the Four Layers into which it was Subdivided. Plans of the objects found and recovered in each layer are shown in Figs. 214, 215, 216.

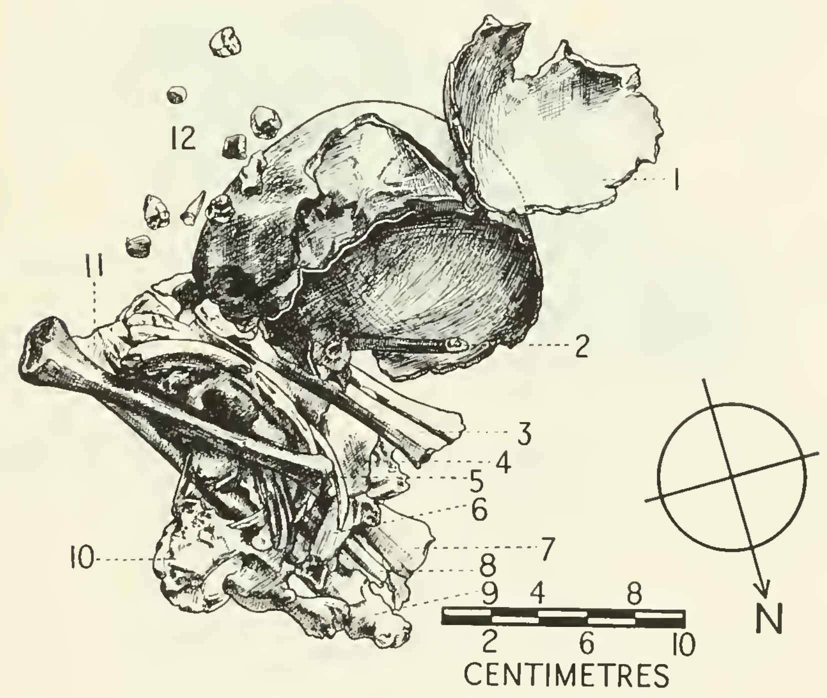


Fig. 214. The Skull and Skeleton of Skhūl I, Viewed from Above. 1, frontal fragment; 2, left radius; 3, right tibia and fibula; 4, right ilium; 5, left humerus; 6, first sacral segment; 7–8, left tibia and fibula; 9, left femur; 10, left ilium; 11, left knee; 12, loose teeth from the destroyed maxilla.

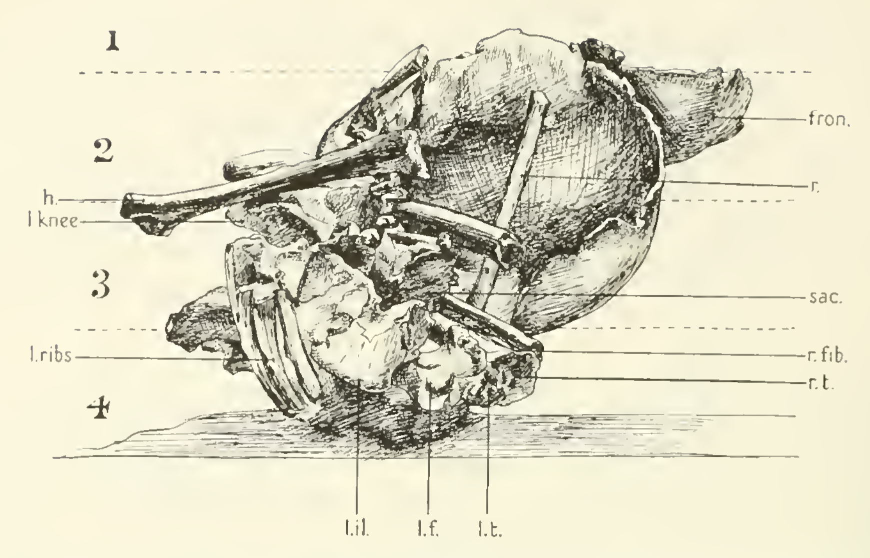


Fig. 215. The Skull and Skeleton of Skhūl I, Viewed from the Left Side. *fron.*, overturned frontal bone; *r.*, left radius; *l.f.*, left femur; *l.t.*, left tibia; *r.t.*, right tibia; *r.fib.*, right fibula; *sac.*, first sacral segment; *h.*, left humerus; *l.knee*, left knee; *l.ribs* left ribs; *l.il.*, left ilium.

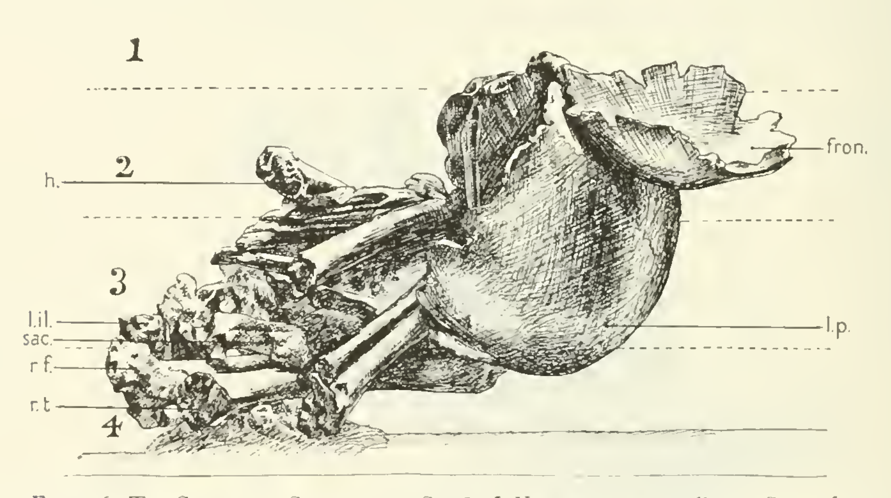


Fig. 216. The Skull and Skeleton of Skhūl I, Viewed from the Right Side. *fron.*, frontal bone; *l.p.*, left parietal; *r.*, left radius; *h.*, proximal end of left humerus; *l.il.*, left ilium; *l.f.*, head of left femur; *l.t.*, distal end of left tibia; *sac.*, first sacral segment; *r.t.*, distal end of right tibia; *r.f.*, right femur shaft.

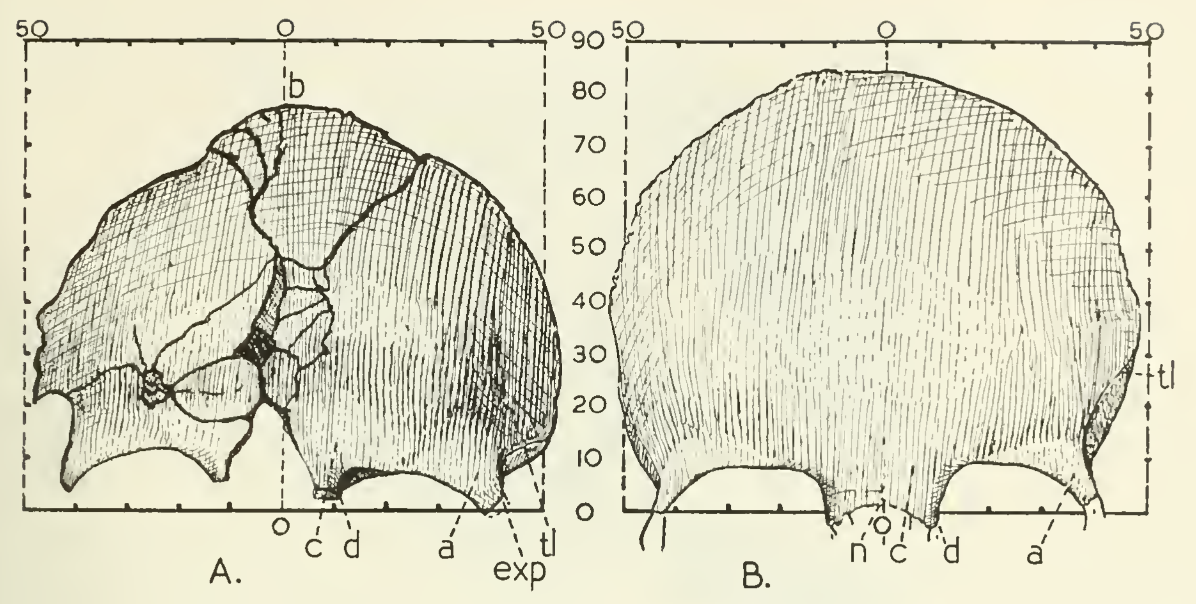


FIG. 217. ANTERIOR ASPECT OF THE FRONTAL BONE ORIENTATED IN THE FRANKFORT PLANE. A, Skhūl I; B, Negro child; *a*, lateral part of supraorbital margin; *tl*, temporal line; *b*, bregma; *c*, medial part of supraorbital margin; *d*, dacryon; *n*, nasion.

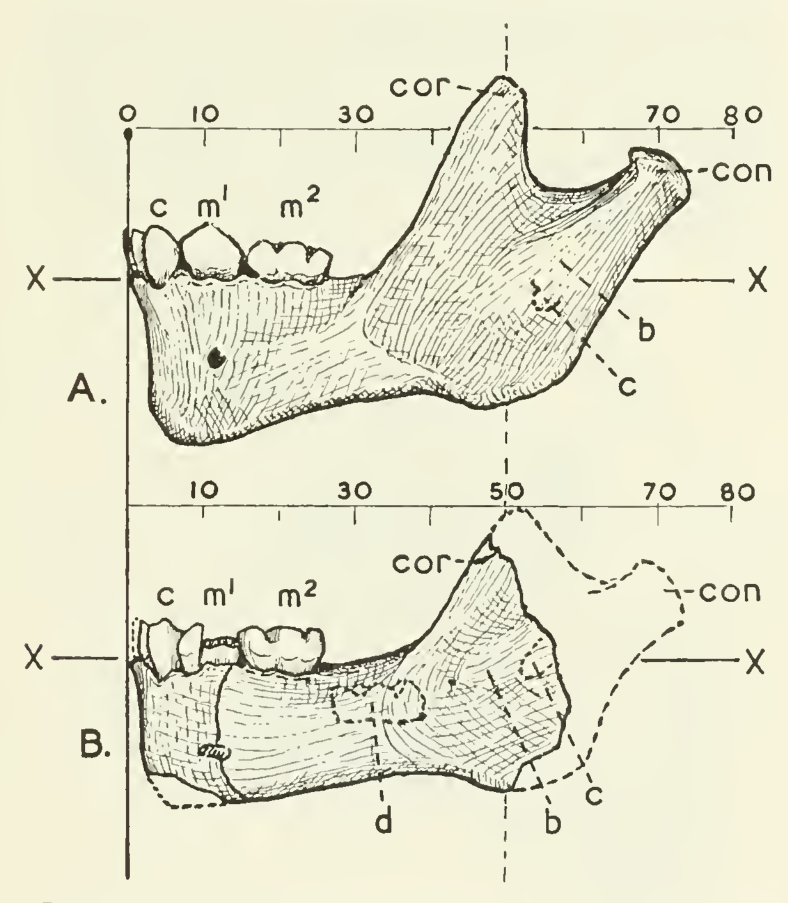


FIG. 218. LEFT LATERAL ASPECT OF THE JUVENILE MANDIBLE. The specimens are orientated on the alveolar plane (Figs. 143–8) and viewed at right angles to the sagittal plane. A, Negro child (*c.* 4 years); B, Skhūl I (reconstruction); *con*, condyle; *cor*, coronoid process; *b*, ramal buttress; *d*, unerupted crown of M–1; *c*, position of mandibular foramen.

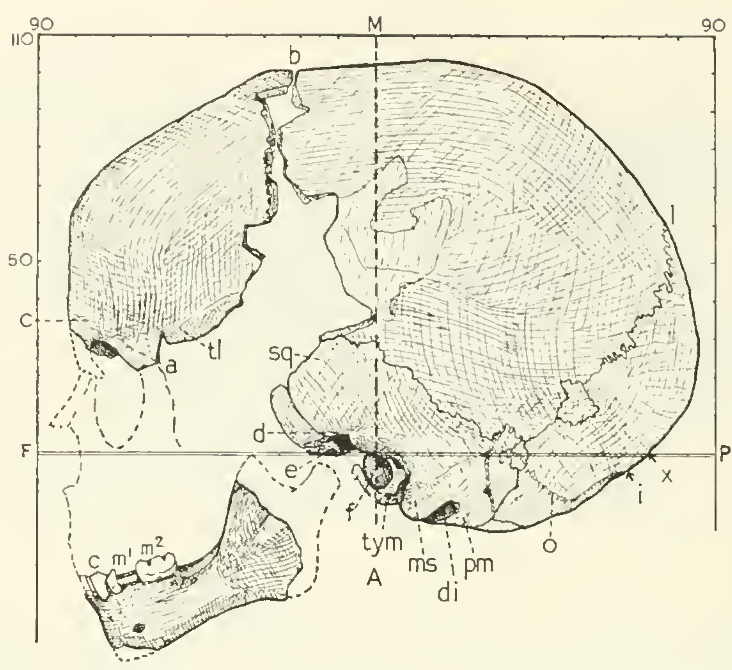


FIG. 219. SKHŪL I, IN NORMA LATERALIS (RECONSTRUCTION). The specimen is orientated on the Frankfort plane (inferred) and a framework of lines is used similar to that employed in Figs. 165, 181, &c. The parts missing on the left side have been supplied by transposing those preserved on the right side. *c*, supraorbital element of orbital margin; *a*, supraciliary element of orbital margin; *t*, temporal line; *d*, upper margin of the puncture at the root of the zygoma which carried away the post-glenoid spine; *e*, articular eminence; *f*, promontory on inner wall of tympanum; *tym*, posterior wall of tympanic plate; *ms*, mastoid process; *di*, digastric fossa; *pm*, paramastoid eminence; *i*, site of inion; *x*, upper margin of X-shaped inial depression (Fig. 222 A, *x*); *o*, limit of attachment of neck muscles; *b*, site of bregma; *l*, lambda; *sq*, squamosal.

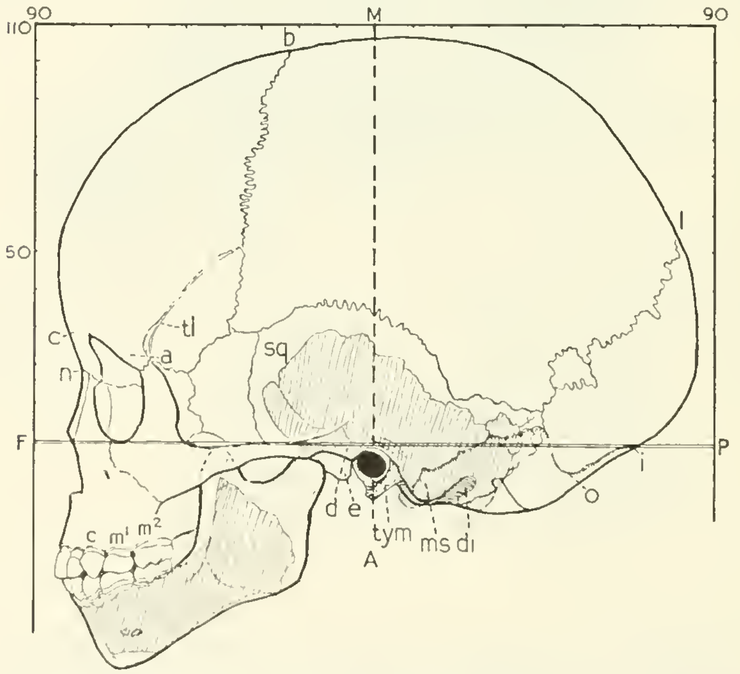


FIG. 220. NEGRO CHILD. Skull of a Negro child at the same stage of dental development and of nearly the same dimensions as that of the Carmel child. Shaded outlines of the mandible and squamosal of the Carmel child have been superimposed on the corresponding area of the skull of the Negro child. Letters have the same significance as in Fig. 219 except that here '*d*' indicates the site of injury in Skhūl I

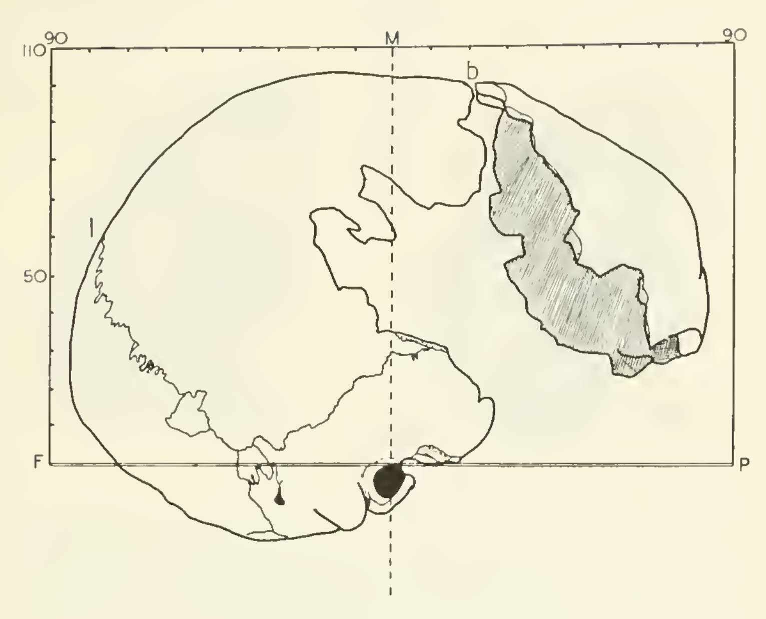


FIG. 221. SKHŪL I, IN NORMA LATERALIS (OUTLINE). Orientated as in Fig. 219.

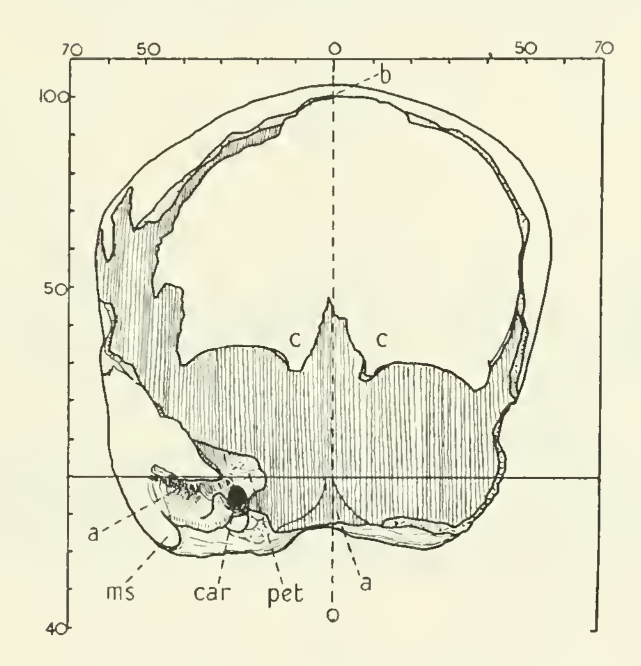


FIG. 222. SKHŪL I, IN NORMA FRONTALIS (OUTLINE). *a*, auditory meatus; *ms*, mastoid process; *pet*, petrous bone; *car*, carotid canal; *d*, lower part of internal occipital crest; *cc*, right and left parts of the interorbital process (fractured); *b*, bregma.

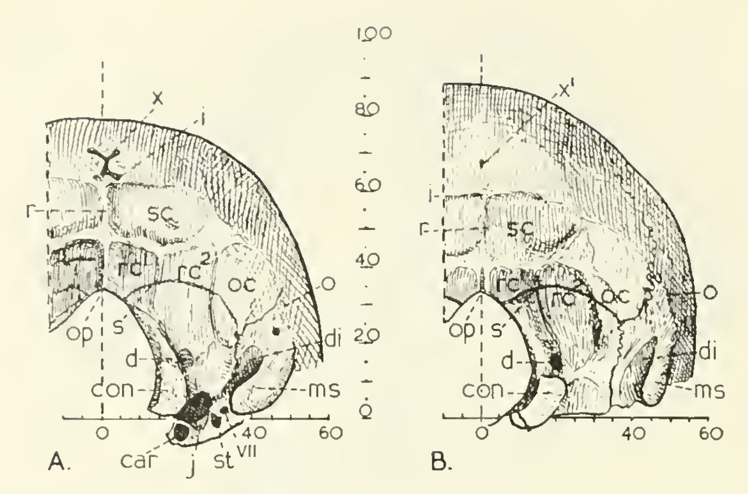


FIG. 223. THE NUCHAL AREA OF THE SKULL. A, Skhūl I; B, Negro (child). *con*, right occipital condyle; *d*, post-condylar depression; *op*, site of opisthion; *r*, median occipital ridge; *x*, X-shaped furrow; x^1, slight fossa; *s*, suture between ex-occipital and supra-occipital; *i*, site of inion; *sc*, area for insertion of complexus muscle (semispinalis capitis); rc^1, area of rect. cap. post. min.; rc^2, for rect. cap. post. maj.; *oc*, for superior oblique; *o*, occipital line or ridge marking limit of attachment of neck muscles; *di*, digastric fossa; *ms*, mastoid; *j*, jugular foramen (right); *st*, styloid fossa; *VII*, for facial nerve; *car*, carotid foramen.

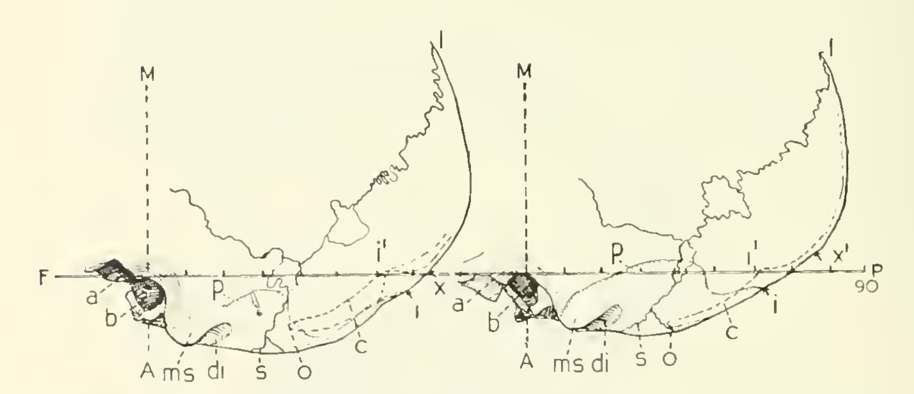


FIG. 224. THE LOWER POST-AURICULAR REGION OF THE SKULL. A, Skhūl I; B, Negro child. *M–A*, mid-auricular plane; *a*, region of the post-glenoid spine; *b*, inner wall of tympanum bounded below by the tympanic plate; *ms*, mastoid process; *di*, digastric fossa; *s*, masto-occipital suture; *o*, position of opisthion (indicated in its raised position in A); i^1, internal inion; *i*, inion; *x*, upper limit of X-shaped inion groove; x^1, small pit in B; *l*, lambda; *p*, limit of attachment of neck muscles; *c*, internal medial crest.

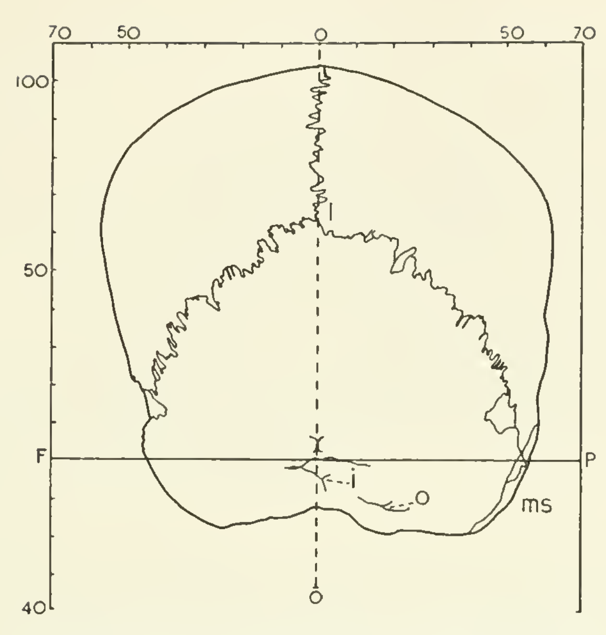


Fig. 225. Skhūl I, in Norma Occipitalis (Outline). *l*, lambda; *i*, inion; *ms*, mastoid process; *x*, X-shaped suprainial furrow; *o*, limit of attachment of neck muscles.

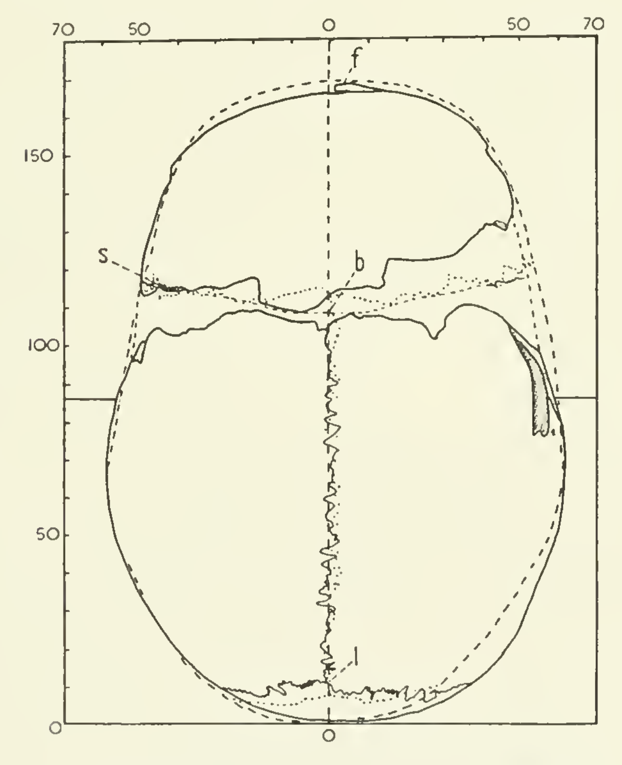


Fig. 226. Skhūl I, in Norma Verticalis (Outline), with the Outline of a Negro Child Superimposed (Broken Line). *b*, position of bregma; *l*, lambda; *f*, fractured inner margin of left orbit; *s*, coronal suture.



CHAPTER XX

JUVENILE SPECIMENS

THE SKELETON OF SKHŪL I; SKHŪL VIII; SKHŪL X

SKHŪL I (Pl. XXIII; Figs. 227–37)

BONDS of breccia were left between the various bones, so that the parts of the skeleton remained in the posture they had occupied in the grave. After the drawings shown in Figs. 214–16 were made, the bones were separated. Measurements were then made and the following description drawn up:

Stature and Proportions.

We have the shafts of the left femur and tibia to serve as a basis for estimating the stature of the child. The upper and lower epiphysis of the femora and tibiae are missing, but in the left limb the diaphyses of both bones are sufficiently preserved to give us accurate measurements. The maximum length of the diaphysis of the left femur of the Skhūl child is 179·5 mm. In an English child in which the teeth and the femur are in the same stage of development as in the Carmel child, namely, that reached between the fourth and fifth years, the shaft of the left femur measures 182 mm. We find that the epiphysial ends make up about 10 per cent. of the total length of a child's femur; therefore we have to add 20 mm. to the length of the Skhūl diaphysis, making its original length 199·5 mm., or in round numbers, 200 mm. To the shaft length of the English child must be added 20·2 mm., making its total length 202·2 mm. The diaphysis of the left tibia of the Carmel child measures 156 mm., that of the English child, 149 mm. As the shaft forms about 85 per cent. of the total length of the tibia we have to add 27 mm. to the Palestinian length, making it 183 mm., and 26 mm. to the English tibia, which becomes 175 mm. Thus the combined lengths of the femur and tibia in the Carmel child yield a total limb length of 383 mm., the English child 377 mm. The ancient child is rather the longer limbed.

Now British children of four years of age have a mean stature of 39·2 in. (995 mm.) for boys and 38·4 in. (975 mm.) for girls. We take our data from Miss R. M. Fleming's (1933) measurements of school-children in Wales. We presume, therefore, for lack of better data to guide us, that the Skhūl child, presumably a boy, was of about the same stature as European children aged four years—about 39·5 in. (1,003 mm.).

The length of the humerus of the Carmel child is in keeping with this estimate. The epiphyses are missing from the left humerus but the diaphysis is almost complete; adding 5 mm. for a fragment missing at the proximal end, it measures 141 mm. In the English child a comparable measurement gives 133 mm. The missing epiphyses make up about 10 per cent. of the total length, so that the original length was about 156 mm. in the Carmel child and 147 mm. in the English child. The Skhūl child had a longer humerus than its English counterpart, but that may be due not to a greater stature but to a relatively longer upper arm.

The diaphysis of the left radius is complete and measures 103 mm., while the shaft in the English child is 5 mm. less (98 mm.). The epiphysis should form about 5 per cent. of the total length, so we infer that the intact Carmel radius measured 108 mm., that of the English child, 103 mm. The radial length in the Carmel child is 69·6 per cent. of the humeral, in the English child 70·5 per cent., almost the same radio-humeral ratio.

There are two ratios in the Carmel child which depart from those holding for modern white children. The length of the femur is concerned in both. This is a short bone when compared with the length of the tibia and humerus. In the English child used for comparison the left tibia forms 86·5 per cent. of the femoral length; in the Skhūl child, 91·5 per cent., a ratio which occurs in brown and black modern races. Then, in the modern white child, the length of the humerus represents 72·7 per cent. of the femur length; in the Carmel child this ratio is 78 per cent. The Neanderthal femur is relatively long when compared with the tibia, the opposite of the condition in the Skhūl child. In the proportion of limbs and limb segments, the Carmel infant agrees with modern races rather than with the European Neanderthal type.

We are now to pass in review the individual bones, but we may say now that the measurements we have made on them bring out very few points wherein the Carmel child differs in a distinctive way from modern children. As in the skull, the racial features are anatomical rather than metrical.

Femur (Pl. XXIII B).

As already mentioned, the diaphysis of the left femur is almost complete; as will be seen from Fig. 227 the medial part of the distal end is missing. As in modern bones this descends about 2 mm. lower than the lateral extremity. It is likely that in its original state the left diaphysis measured 182 mm., the same as in the English child which we used for comparison. Of the right femur we have two-thirds of the diaphysis, beginning proximally at the base of the trochanter minor. At the mid-point of the left diaphysis the circumference measures 42 mm.; the same point of the right gives the same circumference and has identical diameters. The index of robusticity is 23·3. The index is higher in the English child, its circumference at the mid-point being 45 mm.

In Fig. 227 A we give a drawing of the flexor or posterior aspect of the left femur of the Carmel infant set beside a similar drawing of an English bone (B). We have made sectional outlines at three points shown in our drawing with the outlines placed by the side of their sites. The upper sections are made 10 mm. below the base of trochanter minor, the greatest diameter at this site in the Carmel femur being 18 mm., the least, 15 mm. The corresponding measurements in the English bone are 18 mm. and 14·2 mm. The measurements fail to bring out a difference which is apparent in the transverse sections, and more so in the actual specimens, a roundedness of outline in the Skhūl specimen, a character very evident in the original Neanderthal femur.

Similarly at the mid-point of the shaft, the outline of the Carmel shaft is more rounded. The greatest diameter (dorso-ventral) in the Carmel specimen is 14 mm., the transverse 12·4 mm.; in the English femur the corresponding measurements are 15 × 13 mm. The linea aspera has an equal development in both. There is no sign in the Carmel femur of the front to back flattening which is seen in the Tabūn woman's femora or that seen in Skhūl VII, also a woman; nor is there an equality of the two diameters as in the Nean-

derthal femur. We seem to see in this child's bone beginnings which lead on to the narrow-shafted, pilastred femora met with in two of the Skhūl men, Skhūl IV and V.

The shaft of the Carmel femur is nearly straight. The curvature index measured as in Martin (27) is 1·28 (length of chord 140 mm., subtense 1·8 mm.). The index of curvature in the English bone (shown in Fig. 227 B) is 2·06.

In our examination of the skull of the Carmel child, the characters we met with inclined us to regard it as that of a girl, although the large crown of the first permanent molar seemed in contradiction. In the femur we meet with characters which are distinctly against our original diagnoses; its characters are much as we should expect to find in a boy.

Nor are the differences at our third site of section significant. The maximum and minimum diameters in the English child are the greater, namely 15 × 14 mm., against 14 × 13 mm. The linea aspera is more distinct in the Carmel child, is not so flat and not so wide as in the English femur. The muscular markings are much alike in the two femora shown in Fig. 227. The gluteal ridge is much more prominent and tuberculated in the Carmel than in the English bone; its length, 41 mm., extends lower in the shaft than in the English specimen. There is no sign of a third trochanter. Between the gluteal ridge and trochanter minor on the posterior aspect is a triangular area, base upwards. This is more extensive in the modern bone.

From our drawings (Fig. 227 A) it will be seen that the linea aspera of the Carmel femur is divisible into proximal and distal moieties. In the proximal moiety the linea is almost reduced to a line, so closely do the lateral and medial vasti approximate to each other. This condition is also noticeable in the original Neanderthal femur. In the modern femur the proximal and distal moieties of the linea are equally prominent.

Although the neck of the Carmel femur is defective—the distance of the lateral aspect of the base of the great trochanter from the most medial point of the diaphysial neck can be measured; it is 41 mm., against 42 mm. in the modern bone. Along its axis, the anterior surface of the neck is concave; but at a right angle to this axis, the convexity is less than in the modern bone.

In its measurements and in the relationship of one measurement to another, the femur of the Carmel child finds its affinities in the femur of the modern or Neanthropic child. And yet when we lay the femur of this child beside a robust Neanderthal bone, one is struck by a myriad of anatomical resemblances, not seen when a modern thigh bone is compared. We have no doubt the femur of the Carmel child represents an infantile stage in the growth of the Skhūl femur.

We are greatly indebted to Professor H. A. Harris for a report on the X-ray appearances of the Carmel femur. Its dimensions, he reports, are those found in modern English children between three and a half and four and a half years of age. The bone is so permeated with lime deposits that details of structure were not obtainable.

Tibia and Fibula (Pl. XXIII C, E).

In Fig. 228 we give a drawing of the anterior aspect of the left Carmel tibia. Side by side with it we give a similar drawing of the left tibia of a medieval English child. Both are arranged on the same vertical line, one which unites the mid-point of the area of the anterior tuberosity for insertion of the quadriceps, and a point at the distal end of the diaphysis, midway between the medial and lateral borders. Also the shaft was set

so that about equal amounts of the medial (subcutaneous) and lateral (muscular) surfaces are exposed.

As already mentioned, almost the whole of the diaphysis of the left tibia is preserved; it measured 156 mm.; of the right tibia the distal 138 mm. was present. The two tibiae are equal in strength; at the mid-point of the shaft each measured 38·5 mm. in circumference. A little more distally, at the usual site of minimum circumference, the measurement was only 0·5 mm. less. At the mid-point of the tibia in the English child the circumference measures 40 mm. If we accept 183 mm. as the length of the entire Carmel tibia in life, then the index of robusticity was 21, which is of the same order as the indices of the adult Skhūl individuals and much lower than in the tibia of adult Neanderthalians. The index in the English child is 24·4, from which it will be seen that the tibia of the Carmel child was relatively slender, especially when we take into account the great volume of the extremities of the diaphysis. For example, sections of the distal ends of the shaft of the Carmel and English tibiae are given in Fig. 228 *z*. The sections were made 12 mm. above the distal end of the diaphysis, that of the Carmel tibia being 20 mm. wide and 16 mm. in its dorso-ventral direction; the corresponding measurements in the English tibia were 16·5 × 15 mm. As will be seen from our drawing (Fig. 228), the anterior tuberosity and the sub-tendinous area above the tuberosity are more robustly developed in the Carmel than in the English child. And yet when we take the diameters of the shaft at the level of the anterior tuberosity we find them to be almost the same in the English as in the Skhūl child. In Fig. 228 sections are given of the two tibiae at the level of the nutrient foramen (*x*) and at mid-point of the shaft (*y*). The diameters of the shaft of the Carmel child at the nutrient were 16 × 13·5 mm.; in the English child, 17 × 14 mm.; at mid-point the Carmel diameters were 13 × 11 mm., the English 14 × 11·2 mm. Neither in its absolute diameters nor in their proportions does the Carmel child differ significantly from the modern child, yet to the anatomical eye the Carmel tibia is altogether peculiar in its appearance.

Some of these differences are brought out in our drawing. The lateral border of the Carmel tibia will be seen to be concave in outline, while that of the English tibia is almost straight. This concavity is due chiefly to the fact that the proximal and distal halves of the Carmel tibia form a wide angle, which opens laterally, whereas in the modern bone the distal shaft continues in the axis of the proximal half. The Carmel form is associated in modern humanity with bow legs, knees apart, and tibiae approximating as they descend to the ankles.

When, however, we compare the Carmel and modern tibia, not in the front to back, but in the side to side plane, then the case is reversed: the Carmel tibia is the straighter. If we measure the anterior curvature of the Carmel tibia between the depression above the insertion area of the anterior tuberosity and that above the distal fifth of the shaft, the distance being 100 mm., the anterior curvature rises only 1·2 mm. above the line joining the two depressions, whereas in the modern tibia the distance is again 100 mm., but the height of the curvature formed by the crest of the tibia is 3·5 mm. The state of affairs is similar if we measure the curvature formed by the posterior aspect. The height of the curvature is 7 mm. in the Carmel specimen and 10·5 mm. in the modern example. The adult Skhūl tibia is also remarkably straight, the opposite of the Spy tibia. The crest of the tibia shows the same stage in the evolution of the lower curvature which we met with in adult specimens (pp. 45–6). In the modern tibia the crest forms two curvatures, a

proximal one, concave laterally, and a distal, convex in the lateral direction. In the Spy tibia the proximal concavity resembles that in the anthropoid tibia. In the Carmel child the distal part of the crest is almost straight, but there is an indication of the convexity. We met with the same evolutionary stage of the crest in the Skhūl and Tabūn tibiae.

In the English example with which we compared the Carmel child's tibia, the distal end was rotated outwards 10° more than in the Carmel child. We infer that this implies that the Carmel child turned its foot inwards more than the modern child did in walking.

In the Carmel tibia, as in the femur, we see in the general contour certain Neanderthaloid features, but the resemblances to the modern type predominates, even in the infantile stage of development.

Fibula.

Of the fibulae we have the complete diaphysis of the left bone, measuring 150 mm. in length. At its mid-point, its greatest diameter is 7 mm. (in a transverse direction); its least, 6 mm. (antero-posterior). At this point there are four surfaces, anterior, medial, posterior, and lateral, the medial and lateral being the most extensive and of about equal size. Of the right fibula we have 124 mm.—the deficiency being chiefly at the proximal end. Its diameters are somewhat less than those of the left bone.

The middle portion of the shaft is remarkably straight and uniform in size. The distal fourth is flattened from side to side and bends laterally as it descends. Its greatest diameter measures 8 mm., its least, 4·8 mm. The proximal fourth at first bends laterally, but just as it approaches its end, turns medially. The least circumference, situated in the proximal fourth of the shaft, measures 17·8 mm. Save for its curvatures, we see no point in which the fibula of the Carmel child differs from that of a modern child of the same age.

The interosseous border is particularly well demarcated. As it approaches the proximal end of the shaft it joins the anterior border. Similarly at the distal end, it comes forward to join the anterior border, 20 mm. above the termination of the diaphysis. The surface for giving origin to the tibialis posterior is extensive, being 5 mm. wide over a considerable part of its course.

Humerus.

In Fig. 229 A, B, we give two drawings of the diaphysis of the left humerus, which is complete save for a part at the proximal end indicated in our drawings by stippling. The stippled area is copied from the right humerus, of which the proximal end is nearly complete; the middle part of the right shaft is also preserved. The minimum circumference of the left bone, just beyond the deltoid eminence, measures 32 mm.; of the right, 33·5 mm., the greater circumference being an indication of right-handedness. As reconstructed in Fig. 229 A, the length of the diaphysis is 141 mm., the original length we estimate to have been 156 mm.—9 mm. more than the humerus of the English child at the same stage of dentition. The humerus is relatively long and is fairly robust. The index of robusticity of the left is 20·5, about two units below that of the Neanderthal humerus but two units more than is usual in the humeri of Skhūl adults.

Let us deal first with a Neanderthal character; the extremities are large in comparison

with the thickness of the shaft. This we found to hold true of the diaphysis of this child's femur and tibia. For example, the width of the distal end of the humeral diaphysis in the Carmel child is 30·5 mm. We found that the great width of the distal extremity of the humerus was a character of the Skhūl adults. Indeed the humerus of the Carmel child foreshadows in all its characters those of the adult Skhūl humerus.

In Fig. 229 D we give a transverse section of the shaft across the pectoral ridge, at the side indicated in Fig. 229 A, *x*. This ridge appears as if it had been gnawed by a small carnivore, but it is intact in part of the right fragment. The section of the humerus is wedge-shaped, the pectoral ridge forming the apex of the wedge. The greatest diameter at this point is 13 mm., its least, 9·4 mm. The medial surface is flattened, the lateral convex. On the medial surface, at the point of section, is a ridge for the insertion of the latissimus dorsi. Behind it is a depression for the teres major, but there is no distinct trace of the bicipital groove, although it should be evident at this level. The impression for the deltoid muscle descends to a more distal point of the shaft than in the modern bone. The groove for the radial nerve is well marked (Fig. 229 B, *b*). The diameters of the shaft near the mid-point, beyond the deltoid impression, are (dorso-ventral) 10·2 mm., (medio-lateral) 9·8 mm. In section the shaft is triangular.

As will be seen from the drawings in Fig. 229, the shaft of the bone is remarkably straight. This is also the case in the humeri of the adult Skhūl people. The degrees of curvature can be deduced from our drawing.

Humerus of Skhūl X. From a study of the teeth and mandibular fragment of this child we concluded it must have been at least a year older than the Carmel child. The only part of the skeleton is the distal end of the right humerus. A drawing of this is given in Fig. 229 C. It has been reversed to make it comparable with that of the Skhūl I. The fragment is sufficient to show that the width of the distal end must have been about 34 mm., 3 mm. more than in the Carmel child. The dorso-ventral diameter of the distal part of the shaft is 1 mm. more than in that of the Carmel child.

There is one interesting difference between these two Skhūl children; in Skhūl X part of the olecranon fossa is perforated, forming a foramen which is 10 mm. wide and 8 mm. in a proximo-distal direction. The olecranon fossa is very extensive and also deep in Skhūl X, much more so than in the humeri of modern children. Its width is 20 mm., its proximo-distal diameter, 12 mm., its depth, 6·5 mm. In the Skhūl I humerus the fossa is wide, 17 mm., but its two other diameters are not remarkable; proximo-distal 10 mm., depth, 3·5 mm. These dimensions are found in the humeri of modern children. A large olecranon fossa is a Neanderthaloid character.

Radius.

We have only one radius of Skhūl I. The proximal half is complete but the distal half is made up of fragments, the distal end of the diaphysis being represented by an imperfect piece. In Fig. 230 we give two drawings of the radius, (A) a volar view, and (C) a lateral view. With these are placed two similar drawings of an English child of like age. The index of robusticity is very similar in both; at the middle of the diaphysis the circumference is 22 mm. in each, but the Carmel bone is slightly the longer. The index for it is 20·3; in the English specimen, 20·7. In the adult Skhūl men (IV and V) the index is 15 and 16, being relatively more slender. Yet we have every reason to suppose that the

condition seen in the Carmel child's radius represents a stage in the growth of the adult Skhūl radius.

The diameters of the shaft at its mid-point are: Skhūl I, 7·6 mm. wide × 6 mm. in its dorso-ventral diameter; in the modern child the corresponding measurements are 8 mm. × 6 mm. It will be remembered that among the adult Palestinians we met with two types of radius, the much curved Neanderthal form in the Tabūn woman and in one of the Skhūl women (Skhūl VII), and the straight type in the Skhūl men. In the Carmel child we have the straight type, almost ultra-modern in this character. As will be seen from our drawings in Fig. 230, the neck of the Carmel radius is set at the same angle to the shaft as in the English child, both when viewed from the front (A) or from the side (C). In the English radius (B), the axis of the neck is directed towards the distal radio ulnar joint, and if the distal end had been complete in (A) this would probably also have been the case too. But when seen from the side (C) the shaft of the Carmel radius is the less curved, even when we allow for the defect of the distal end and the reconstructed nature of the distal half of the shaft.

The two bones compared in Fig. 230 differ in features of the neck. The neck of the modern radius has a circumference of 30·5 mm. (diameters 10 × 9·2 mm.); that of the Carmel child 26 mm. (diameters 8·2 × 7·3 mm.). In this respect it is the modern bone which is exceptional, for in radii of modern children of native races the circumference of the neck is relatively the same as in the Carmel child. Nor has the Carmel radius a long neck as in Neanderthal bones; it measures 16 mm., against 17 mm. in the English child's radius shown in Fig. 230 B, D. On the other hand the bicipital tuberosity of the Carmel radius is small and is situated more towards the medial (ulnar) border than in the modern child.

The proximal epiphysis, a thin, rounded disk, adheres to the proximal end of the diaphysis.

In brief, the radius of the Carmel child is chiefly Neanthropic in its characterization and represents the infantile stage of the male Skhūl type.

Clavicle (Pl. X).

We have described the long bones of the limbs of the Skhūl child, the femur, tibia, fibula, humerus, and radius. We propose now to examine and describe such parts of the shoulder and pelvic girdle as are available. Of the shoulder we have only one part, the clavicle of the left side (Fig. 231). It is almost intact. Its extreme length is 73 mm.; at its mid-point its circumference is 17·5 mm. Its index of robusticity, $\frac{17{\cdot}5 \times 100}{73{\cdot}0} = 23{\cdot}9$, is less than in Neanderthal or Skhūl adults, but equal to the robusticity of the clavicle of the adult Australian aborigine. The length of the clavicle represents 46·7 per cent. of the length of the humerus, nearly the same proportion as in the Tabūn woman, but less than in the Skhūl men. Nevertheless, the clavicle of the Carmel child would have grown into the peculiar form seen in Skhūl V (Figs. 95–6).

The section shown in Fig. 231 D, and made at the site indicated in (A), gives the chief character of the Skhūl clavicle, its compression or flattening in a cranio-caudal direction. At its mid-point the maximum diameter of the clavicle is 6 mm. (in an oblique cranio-caudal direction); its least diameter 4 mm. On the cranial surface is seen the impression

for the clavicular origin of the pectoralis major (Fig. 231 A, *d*); on the under surface, the groove for the insertion of the subclavius.

The extremities are relatively large. A drawing is given of the sternal end (Fig. 231 C); it approaches a square in shape, its diameters being equal (10 mm.). The acromial end is 12·3 mm. wide and 6 mm. thick. The facet for the acromion measures 11 × 5·7 mm.

A child's clavicle was found at Krapina. Its length is not quite 60 mm. and its medial curvature is not yet developed. It probably belonged to a child of two years; the Carmel child was at least two years older than the Krapina child. In the Carmel clavicle both medial and lateral curvatures are already well developed. The anterior convexity, measured as described by Martin (2), has a curvature index of 9·1; in the adult Neanderthal the index is greater, 11·3; in Skhūl V, 12; in an Australian, 11·6. There is no other example of a mid-Pleistocene clavicle at the Carmel stage of development.

Pelvis.

There are three parts of the pelvis of Skhūl I: (1) the greater part of the left ilium, shown in Figs. 232, 233; (2) a smaller part of the right ilium; (3) part of the first sacral vertebra (Fig. 234 B).

When we drew up a preliminary report on the Carmel child, before the discovery of the adults, we were impressed by the 'ultra-human' characters of the ilium, namely, the shallowness of its iliac fossa and its width. The ilium is the opposite of the same bone in an anthropoid, where it is high and relatively narrow.

These peculiar features of the child's pelvis were elucidated by the form of pelvis we met with in the adult Skhūl men, particularly in Skhūl V. It will be remembered that the ilium was particularly low and shallow, just as we had found in the Carmel child.

In Fig. 232 A we give a drawing of the medial aspect of the left ilium of the Carmel child and have placed beside it a similar drawing of a modern child (B). On the medial aspect of the Carmel ilium three important points are preserved: (*a*) the anterior-superior iliac spine; (*b*) the retro-iliac tuberosity, the rough area which marks the attachment of the ilio-lumbar ligament and the posterior limit of the origin of the iliacus muscle (Figs. 232, 233 *b*); (*c*) a small area of the anterior or ventral margin of the auricular surface for the sacrum. These three points are indicated in Figs. 232 and 233, in both modern and ancient ilia.

In nearly all comparisons we have made between the English child and the Carmel child, the English measurements have been somewhat smaller. Here they are nearly the same. The distance between *a* and *b* (Fig. 232) in the Carmel ilium is 59 mm.; in the English 57 mm.; the distance of *e* from *a* in the Carmel child is 46 mm.; in the English 45 mm.

Thus in width the Carmel ilium is the larger, whereas in height it is much the lower. In the Carmel child the anterior border of the ilium, from the anterior-superior spine to the nearest point on the acetabular margin, measures only 18 mm., but is 28 mm. in the English child. Or, if we take the height of the ilium from acetabular margin to crest, at the situation of the tuberosity of the crest (Fig. 233 C, D), it is 38 mm., against 48 mm. in the modern bone. The height of the ilium from acetabular margin to the most distant point on the crest is 51 mm. in the ancient, 59 mm. in the modern child. The width of ilium represented by *a*–*b* in Fig. 232 is 8 mm. more than the height in the Carmel child.

It is 6 mm. less than the height in the modern child. The peculiarity lies not in their respective widths but in their respective heights. The Skhūl pelvis has a shallow iliac basin and low iliac crest.

There is a difference in the conformation of the acetabular margin. In the modern child it is a raised ridge with a single margin, whereas in the Carmel ilium the acetabular margin is sunken and grooved, forming a double margin (Fig. 233 A, B).

In the adult Skhūl pelvis, as we have already seen, the tuberosity of the crest is exceptionally well developed and is situated relatively near to the anterior-superior iliac spine. In Fig. 233 C, D, we compare the iliac crests of the Carmel and modern child; the crest is wider at the tuberosity of the Carmel child (7·6 mm.) than in the modern (6·2 mm.). The tuberosity of the iliac crest is a specialization for the human mode of progression.

The ilium is less curved, rather flatter, in the Carmel than in the modern ilium. The iliac fossa is particularly shallow and the iliac plate is not so thick as in our modern specimen.

Vertebral Column.

Sacrum. We begin our description of the vertebral column of the Carmel child at the sacrum. This follows naturally from the last section, in which we gave an account of the pelvis. We begin with the sacrum for the following reason. In considering the long bones of the child's limbs we found an English child the best modern subject at our disposal for comparison; as a rule the Carmel limb-bones were longer than the English ones used for comparison. But when we compare the first sacral vertebrae of these two children, as has been done in Fig. 234 A, B, we see that the fossil bone is very much smaller than the modern, yet both bones are at the same stage of ossification. In both, the two elements which make up the lateral mass of the sacrum are undergoing fusion in their peripheral parts, i.e. those entering into the sacro-iliac articulation. Of the material at our disposal, that which most nearly resembles the Carmel sacrum in size and shape (Fig. 234 C) is the sacrum and spine of a Peruvian child (mummified), but this child was certainly at an earlier stage of ossification and of tooth formation than the Carmel child. The long bones of the Peruvian child are 12–15 per cent. shorter than those of the Carmel child. And yet, as will be seen from Fig. 234, the Peruvian sacrum is the larger. This observation recalls the remarkable shortness of spine we found amongst the fossil skeletons from Palestine, particularly in the Skhūl men. The same shortness characterizes the spinal column of the Carmel child.

The sacra of the adult Skhūl people were poorly preserved; we presumed them to have been narrow; it is probable they were even narrower than we inferred.

Of the Carmel sacrum we have the greater part of the first vertebra (see Fig. 234) and a fragment of the second, so imperfect as to be of little help. We made four measurements of sacral width shown in Fig. 234 A (*a–a*, *b–b*, *c*, *d*). We shall consider first the extreme width (*a–a*) taken between the most distant points on the lateral mass. In the Carmel child its estimated measurement is 52 mm., 2 mm. less than in the Peruvian child and 11 mm. less than in the English child of like dental age.

As will be seen from Table LXXXIV (p. 343), the widths in the Carmel sacrum fall below those of the Peruvian child and much below those of the English child. A narrow-

ness of sacrum we regard as a primitive feature. The widths and the dorso-ventral diameters of the centra of the first sacral vertebrae of the Carmel and Peruvian children are almost the same. So, too, are the distal surfaces of the centra. In all three children the cranio-caudal diameters are the same, the anterior (ventral) being 12 mm., the posterior or dorsal, 10 mm. We infer from this that the sacral vertebrae of the Carmel child were, in their height and degree of angulation, similar to those of the modern children here used for comparison. The Carmel child's sacrum was narrow but of 'normal' height or length. The laminae are broken off at their junction with the articular processes. The broken base shows that the diameters at that point were $8 \times 3{\cdot}5$ mm., the greater diameter being the cranio-caudal. The lamina of the second vertebra was wider (9 mm.) and thicker (3·8 mm.). The articular processes were set nearer together than in either of the modern children (Table LXXXIV, line 5, p. 343).

Lumbar Vertebrae. We have fragments of each of the five lumbar vertebrae. The first, second, and third, which are the most complete, remain united by intervening calcareous material. The fourth is represented by a fragment of the centrum and the greater part of the arch; the fifth by two parts of the body, one of them still adherent to the cranial surface of the first sacral vertebra.

As the first lumbar is the most complete of this series we have made it the object of comparative study with the corresponding vertebra of the Peruvian child (Fig. 234 D, E, F, and G). We note on the cranial aspect (Fig. 234 D, E) that the Skhūl child's spinal canal is smaller and more compressed in a dorso-ventral direction than in the modern child, a feature which we met with in the corresponding region of the adult Skhūl spinal column. We note, too, that the neural arch and its processes are more robust in the Carmel child. The difference in the processes is due to the fact that the Carmel first lumbar has assumed the lumbar character to a full extent, whereas the Peruvian child retains more of the dorsal characters, as is the more usual occurrence in modern spines. The ventral part of the centrum is missing in the Carmel specimen, but the impression given is that the ventral margin was less convex than in the modern specimen. The result of our comparison was to impress us with the resemblances rather than with the differences between the fossil and modern vertebrae.

A comparison of the height (cranio-caudal diameters) of the centra brought out the fact that as regards height the bodies of the Carmel lumbar vertebrae are relatively and absolutely shallow, as we found to be the case in the adults; adding the heights of the five Carmel lumbar centra we obtain a total of 55 mm., giving a mean height for each of 11 mm. The total in the Peruvian child is 59·3 mm., giving a mean height of 11·8 mm. As in the adult Skhūl people, the child had a short lumbar region.

The body of the fifth lumbar was wedge-shaped, the ventral height being 10·7 mm., against 8·6 mm. for the height on the dorsal aspect.

An Injury. We have already mentioned that the upper three lumbar vertebrae are still in their natural articulation and cemented together by the cave deposit. A clearly cut perforation $7{\cdot}6 \times 9$ mm. is present in the roof of the spinal canal. The pointed instrument which caused it grazed the upper border of the lamina of the third vertebra and perforated that of the second, carrying in front of it a fragment which still remains applied to the dorsal aspect of the adjoining lamina, that of the first vertebra. To produce such an injury the instrument must have entered on the ventral aspect of the spine and

emerged on the dorsal aspect. The body of the third vertebra is missing; evidently it has been crushed by the impact of the blow. To account for the broken fragment being still *in situ* one has to infer that the parts were held together, either by flesh or soft soil; at least the injury must have been done before fossilization set in. We have already noted injuries to the skull, and particularly to the temporo-mandibular region, by a sharp-pointed instrument.

Dorsal Vertebrae. Of this series we have only two, Dorsal 1 and Dorsal 12, all the intervening members having disappeared. Dorsal 1, as will be seen from our drawing (Fig. 234 H), is almost intact. When compared with Dorsal 1 of the Peruvian child it is seen that in this section of the vertebral column the spinal canal is larger and rounder in the Carmel specimen, the opposite of what we found in the lumbar region. Also it is seen that the neural arch is stronger and its processes longer in the modern vertebrae. It will be noted that the transverse processes in the Carmel vertebra are less bent in a dorsal direction than in the modern vertebra. This, too, we found in the adult Skhūl first dorsal. It is an anthropoid feature indicating a chest which was rounded in its circumference. The first dorsal of the Carmel child retains characters which we are to meet in its cervical vertebrae. Its spinous process is remarkably short and slender (14 mm.). The body is shallow in its cranio-caudal diameter, only 5·8 mm. against 7·8 mm. in the Peruvian child.

The twelfth dorsal is represented by the greater part of the centrum, the pedicles, and the neural arch. The cranial surfaces are damaged and the transverse processes broken away. The neural canal is somewhat smaller than that of the Peruvian infant. There is a facet for the twelfth rib. The dorso-ventral diameter of the body is 16·2 mm., its width 22 mm., a somewhat smaller and narrower bone than the corresponding modern one.

Cervical Vertebrae. All seven are represented, the atlas and axis by mere fragments, but the other five are in natural apposition, being bound together by breccia. Unfortunately the laminae and spines are missing; only bodies, pedicles, and articular processes remain. The general characters of the cervical vertebrae are those we met with in Skhūl V.

Of the atlas we have the dorsal extremities of the lateral mass and adjoining parts of the arch. These indicate that the atlas was similar in size to that of the Peruvian child, in which the extreme transverse diameter is 50·4 mm., the dorso-ventral, 30·5 mm. The dorsal lamina, or arch, is not flattened but rounded and rod-like, the diameter of the most dorsal part being approximately 6 mm.

Two fragments of the axis are very similar to the corresponding parts of the axis of the Peruvian child.

The lower five cervical vertebrae of the Peruvian child are still held together by cartilaginous disks. In the Carmel neck a cement-like material has replaced the disks. The total height of the five bodies, as preserved in these specimens, is 29·5 mm. for the Carmel child, for the Peruvian, 32 mm. Here again we have evidence of the shortness of the Carmel vertebral column. In point of age, the Carmel child is certainly older than the Peruvian child with which we are comparing it (*vide supra*).

As regards shape of centra, pedicles, transverse, and articular processes, we can see no outstanding point in which the Skhūl I cervical vertebrae differ from those of a modern child.

As the seventh vertebra of the Carmel series is the most accessible and most complete of the series we may compare the dimensions of its body to those of the same vertebra in the Peruvian series. The Carmel measurements are: width (of caudal surface), 20·5 mm.; dorso-ventral diameter, 8·7 mm.; cranio-caudal diameter, 4·6 mm. The corresponding Peruvian dimensions are 21·6 mm., 10 mm., 5 mm., in every case being larger than the Carmel.

An examination of the vertebral column of the Carmel child leads us to the conclusion that it represents the immature stage of the condition which we found in Skhūl adults, particularly that depicted in Skhūl V.

The Thorax.

Sternum. There are two parts of the sternum shown in Fig. 235 A. One is a segment of the mesosternum, either the second or third. Its width is 9·8 mm., its length 7 mm., its thickness 5·4 mm. The other we believe to be the right half of the manubrium sterni. It is 22 mm. long; the original width we estimate to have been about 25 mm.; its greatest thickness at the site of the clavicular articulation is 5 mm. We have placed these facts on record for, as far as we can learn, it is the first description given of a sternum of a child of mid-Pleistocene date.

When describing the vertebral column we found that the vertebrae of a Peruvian child, younger in point of development, agreed best with the Carmel vertebrae in point of size. As regards the parts of the sternum those of the Peruvian child are smaller, thinner, and less advanced in development than the corresponding parts of the Carmel sternum. On the other hand, the sternum of an English child of the same 'dental' age as the Carmel child had a corresponding development.

Ribs. In our account of the bones of the Skhūl child we have drawn attention to their resemblance to those of the man, Skhūl V. In the character of its ribs the Carmel child again has resemblances to Skhūl V.

There is no single complete rib, yet all the ribs (with the possible exception of the first) are represented by parts. On the left side there are fragments of the third to twelfth ribs; on the right side, from the second to the eighth and the tenth to twelfth.

First Rib. We give a drawing of the fragment of this rib in Fig. 235 B. We have reversed the drawing from left to right because the other specimens in our illustration are of the right side. We have found it necessary to represent it twice natural size, the original being so small that we hesitated to identify it as the first of a normal series. It is a fragment extending from a point near the angle to the groove for the subclavian artery. On its cranial surface, in front of the angle, is a raised area for the insertion of the scalenus medius (Fig. 235 B, *a*). On the under surface of its dorsal part and indenting the medial border is the groove for the first dorsal nerve (Fig. 235 B, *b*).

Its ventral or grooved part is only 5 mm. wide and 2 mm. thick.

It will be remembered that the first dorsal vertebra of this child had certain cervical features. It is therefore possible that the first rib had some characters of a cervical rib.

Second Rib. On the right side the second, third, and fourth ribs adhere in sequence (Fig. 235 C). The second rib on the right extends from its vertebral connexion almost to its sternal end. Its outer or pectoral surface is strongly convex in section, its diameter 10 mm. distal to the angle being 6·2 mm. (cranio-caudal) and 4·6 mm. (medio-lateral).

Third and Fourth Ribs. As in the adult Skhūl thorax, the third and fourth ribs are remarkably wide in their cranio-caudal diameter, and thin in their ventral or sternal parts. The third rib, distal to its angle, has diameters of 7 × 3·5 mm., the smaller being the medio-lateral. The corresponding diameters towards the ventral end of the fourth rib are 9 × 2·6 mm.

Fifth, Sixth, Seventh, Eighth, and Ninth Ribs. The fifth, a slender rib (diameters 20 mm. distal to the angle: 6 × 3 mm.), is not so curved as in the true diaphragmatic ribs, namely, the sixth, seventh, eighth, and ninth. As in the adult Palestinians, one of the diaphragmatic ribs much exceeds the others in strength. In the case of the Carmel child we believe this to have been the seventh. A drawing of this rib is given in Fig. 235 D with sections made at the sites *x*, *y*, *z*.

The remarkable feature of this series of ribs is the roundness of their shafts, from the mid-axillary line backwards (dorsally) to the tuberosity. As will be seen from the section (Fig. 235 D, *x*) the dorsal part of the seventh rib is only slightly greater in its cranio-caudal than in its medio-lateral diameter (5·8 × 4·8 mm.). Towards its ventral end the diameters are 8 × 3 mm.

Tenth, Eleventh, and Twelfth Ribs. The tenth rib, dorsal to the angle, is rounded in section; ventral to the angle the shaft is flattened, its diameters being 7 × 3 mm.

The eleventh rib is shorter than the tenth but the shaft is equally wide, although thinner. The twelfth rib has its head, neck, and tuberosity so foreshortened that they form a single mass. The shaft of the twelfth at its widest measures only 5·2 × 2·3 mm.

The Hand.

Of the hands we have identified only five items: the shaft of the metacarpal of the right thumb, greater part of the shaft of the third left metacarpal, distal part of the second left metacarpal, and some fragments. The metacarpal bone of the thumb is short (17·2 mm.) but thick and strong, the d-v. diameter at its mid-point being 6·3 mm., its medio-lateral (transverse) being 7·4 mm. The length is nearly the same as in the Peruvian child, but in the Peruvian the shaft is much more slender. The Carmel child had short thick thumbs.

Little need be said of the other metacarpal. The diaphysis of the third (left) we estimated to have measured 27 mm.; its base measures 8·5 mm. (d-v.) × 7·5 mm. (m-l.).

No carpals were found.

The Foot.

The Tarsus. Two bones of the right tarsus are preserved, the talus and the first cuneiform.

The talus is imperfect, its head and the under surface (the body) being deeply eroded. It is longer and more maturely modelled than is the talus of the Peruvian child. For example, the extreme length (Martin 1*a*) is 26 mm. in the Peruvian, 28·5 mm. in the Carmel child. The width (Martin 2) in the first is 17 mm., in the second 19 mm.

The width of the trochlea (Martin 5 (2)) in the Peruvian is 15·8 mm., in the Carmel 17·5 mm. We could detect no feature in the Carmel bone which was not also present in the modern child's talus.

First Cuneiform. A drawing of the medial face of this bone is given in Fig. 237 B.

It is wedge-shaped, base below, apex towards the dorsum of foot. Its height is 10·8 mm., its length 11 mm., width of base 7·6 mm. Here again we have detected no feature which marks this bone off from the modern type.

Metatarsus. As will be seen from Fig. 237 all five metatarsal bones of the right foot are preserved, although all have suffered some degree of damage. The two phalanges of the great toe were also recovered. Only two phalanges of the other toes are in our collection, a proximal phalanx (probably of the second toe) and a middle phalanx of the fourth or fifth. Three fragments of the great toe of the left foot were also found.

First Metatarsal. As will be seen from our Table LXXXV (p. 344), this is a more robust bone than the modern one with which we have compared it. As in the first metacarpal of the thumb, this appears stumpy and strong. The proximal epiphysis is lost; a marginal fragment has been broken from the medial aspect of the base (Fig. 237). The proximal end of the diaphysis is D-shaped in section, the straight limb of the D being placed medially. There is no single diagnostic feature which serves to separate the fossil from the modern form.

Phalanges of the Great Toe (Fig. 237). The length of the proximal phalanx is 10·8 mm., that of the distal 9·3 mm. Thus the total length of the bones of the great toe is 46·6 mm. The phalanges, like the metatarsal, are stout, the base of the proximal being 10 mm. wide × 7·5 mm. thick; the corresponding measurements of the distal phalanx are 8·6 mm. and 5·2 mm.

Second Metatarsal. The distal epiphysis is lost and part of the base of the shaft is broken away. Its length is 28·2 mm., with an original length of about 30 mm. At the mid-point of the shaft the d-v. diameter is 5·3 mm., the medio-lateral 3·7 mm.

Third Metatarsal. As will be seen from Fig. 237 the shaft of this bone is provided with a massive proximal end, which has certain resemblances to the distal end of the adult bone. The base measures 10·5 mm. (d-v.) by 7·4 mm. (m-l.). The total length is 30·5 mm.; at its mid-point the d-v. diameter is 6·6 mm. × 5 mm. (m-l.). It is the stoutest of the four lateral metatarsals.

Fourth Metatarsal. This is the slenderest of the four. Length, 26·8 mm. Diameters at mid-point 5·8 mm. (d-v.), 3·5 mm. (m-l.).

Fifth Metatarsal (see Fig. 237 A). Length 26·8 mm. Diameters at mid-point 5·8 mm. (d-v.) × 4·0 mm. (m-l.). The lateral surface is directed upwards as much as outwards.

Phalanges. Those of the great toe have been described. There are only two phalanges of the other toes, one probably a proximal phalanx of the second toe (Fig. 237 *d*). Its length is 11 mm.; its midshaft measures 3·4 mm. (d-v.) × 4 mm. (m-l.). The other is a mid-phalanx. It is short (8 mm.), straight, conical, and rounded in section.

We have placed on record these facts connected with the bones of this child's foot, not because of their difference from, but rather because of their resemblance to, those of the feet of robust modern children.

THE SKELETAL REMAINS OF SKHŪL VIII

We are of the opinion that the fossil remains are those of a boy about 8 years of age. We have only his lower limbs. It is true there is a fragment of the right ischium, but it is devoid of interest, so far as we can see. Of the left femur there is part of the lower epiphysis; of the right there is a separated part of the shaft, 202 mm. in length, beginning

distal to the lesser trochanter and extending to beyond the mid-point of the popliteal triangle (Fig. 236 A, B, Pl. XXIII F).

By comparing the femoral fragment with the corresponding parts of modern and ancient bones, we have concluded that the original length was about 340 mm. The femur is of the Skhūl type; we are dealing with a Skhūl child.

Both right (Fig. 236 C, D) and left tibiae are represented. In both, the proximal end is missing; the shaft begins just proximal to the nutrient foramen and extends to the ankle-joint, for the distal epiphysis adheres to the shaft in both cases. Part of the upper epiphysis of the left tibia is preserved. It represents the articular surface for the medial condyle of the femur. Indeed, the medial condyle is adherent to the tibial articular plate, but instead of the condyle being in a normal position it is so turned that the medial (inner) aspect of the condyle adheres to the articular surface of the medial condyle of the left tibia. It is a position which could be assumed only after the bones had been forced into an abnormal articulation.

By comparing the tibial fragments with complete specimens we have come to the conclusion that the original tibial length (Martin 1) was about 248 mm. Our estimate makes the tibial length 78·4 per cent. of the femoral length—a ratio which falls within the modern range, but much less than in the case of the Carmel child (Skhūl I).

Our estimate for the length of the femur is 316 mm., for the tibia 248 mm., both together 564 mm.; using the coefficient for smaller bones given by Martin (vol. ii, p. 1069) we obtain a stature of 1,190 mm. (46·8 in.). This stature corresponds to that of modern English boys aged 7½ years. The state of the epiphysis also favours this estimate of age. It is probable that we are under-estimating the length of the tibia. On this and other grounds we place the age of Skhūl VIII at 8 years.

The bones are robust, the feet big; on this account we attribute the bones to a boy. In Skhūl I we have an infantile stage in the development of the Skhūl male type; in Skhūl VIII we have a further stage in the development of this type.

Of the feet, we have the following bones: of the right an almost complete talus and part of the os calcis, a part representing the medial aspect of the whole length of the bone; also the naviculare.

The left foot is nearly complete (Fig. 239 A, B). As will be seen from our drawings, most of the phalanges of the toes are missing; so is a large part of the os calcis. The metatarsal of the great toe has been thrust laterally against the other metatarsal bones, and the diaphysis separated from its epiphysis. The original length of foot we estimate to have been about 165 mm., this foot length representing 66·5 per cent. of the tibial length, a ratio within the range found in modern races (Strauss, 1927, p. 95). The bones of this child are fossilized to the degree which prevails among the other human remains from the Skhūl cave. In colour they vary from a light brown to a straw colour.

We shall now proceed to give a description of the various bones, beginning with the right femur.

In Fig. 236 A we give a drawing of the shaft of the right femur seen from the front. At three points, x, y, z, indicated in our drawing, transverse contours have been drawn and set beside the femoral shaft. The uppermost section (x), made about 1 cm. distal to where the base of the trochanter minor must have been, shows that the upper shaft was

flattened from front to back, in an oblique direction. At this point the section is roughly triangular, the base of the triangle being situated medially, the apex, laterally, representing the gluteal flange or border. On the posterior aspect of the lateral flange is a shallow depression for the gluteus maximus muscle (Fig. 236 A). The transverse diameter at this plane of section is 19·6 mm., the antero-posterior diameter 15·2 mm., the latter being 78·5 per cent. of the former, a ratio which occurs in ancient as well as modern femora.

Section y (Fig. 236) is made at the mid-point of the shaft. Here, too, the shaft is flattened from before back, the diameters being 17 mm. medio-lateral, 15 mm. antero-posterior, the latter being 94 per cent. of the former. Our section shows the degree to which the linea aspera is differentiated at this level of the shaft.

At the lowest level of section made near the middle of the popliteal triangle, the m-l. diameter is 20 mm., the a-p. diameter being 17·5 mm.

On the whole the ratios revealed at the three sections, x, y, z, favour a Neanderthal affinity for this boy, and yet we do not doubt that a few years later, had the lad lived, the ratios would have become those found in the Skhūl men.

In its straightness the shaft of the femur proclaims its Skhūl nature. A characteristic of the Neanderthal femur is its bowing or curvature. In Fig. 236 B we give an exact drawing of the femoral shaft, seen in profile from the inner or medial side. The chords and subtenses for the anterior and posterior curvature are indicated on the drawing. The chord for the anterior curvature is 200 mm., the subtense 5 mm., the ratio being 2·5 per cent. The posterior curvature is a little more, the chord being 192 mm., the subtense 6 mm., the ratio 3·9 per cent., showing how straight the shaft of this femur is. In this the boy differs from the Neanderthalians of Europe and agrees with moderns and with the Skhūl type. On the other hand, the proximal half of the shaft, when viewed from the front, as in Fig. 236 A, does make a decided angle, open laterally, with the distal half, a character well seen in the Neanderthal femur (Hrdlička).

Thus, in the femur of this boy, as in that of the Skhūl adults, we have a mixture of Palaeanthropic and Neanthropic characters, the latter predominating. We suspect that relative to the shaft the extremities of the femur were large, a Neanderthal character. The dimensions of the medial condyle of the left femur support this interpretation.

Tibia. In Fig. 236 C, D, we give two views of the right tibia, from the front and from the side (medial view). The proximal ends are missing on both sides down almost to the level of the nutrient canal. The right fragment measures 187 mm., the left 184 mm., the distal epiphyses making up 13 mm. of this amount. (See Pl. XXIII G, H.)

We draw attention, first, to the anterior border or crest. In the Neanthropic tibia this is divisible into two segments, a proximal which has its convexity directed medially and a distal which is directed laterally. The distal is absent in the anthropoid tibia; it is straight and ill defined in the Neanderthal bone; in the Skhūl tibiae we found it straight or slightly convex. In Skhūl VIII it is straight and not sharp or prominent (see section y).

In Fig. 236 C, we give three sections of the shaft, made at points x, y, z, indicated on our drawing. Let us take the proximal section (x) first; it is made at the level of the nutrient canal. The greatest (which is the a-p.) diameter, measures 24 mm., the least (or m-l.) 15 mm., the latter being 62·5 per cent. of the former, the tibia thus falling towards the extreme platycnemic type. In this, Skhūl VIII resembles the Cromagnons,

and is far removed from the Neanderthal type. The degree of platycnemia, as we have already noted (p. 47) depends on the extent to which the retro-tibial (popliteal) buttress is developed (Fig. 236 C, *x*). It is highly developed in the tibia of Skhūl VIII. The middle section (*y*) is roughly triangular, but it will be noted that both lateral and medial surfaces are convex in section. The diameters at this point are 19 mm. (a-p.), 15 mm. (m-l.), the latter being 79 per cent. of the former. The distal section (*z*) is four-sided. The diameters are 27·8 mm. (a-p.), 31 mm. (m-l.). These diameters are large, again indicating that the limb bones of Skhūl VIII had relatively large extremities. The fragment of the proximal (articular) end of the left tibia also favours this supposition. One notices, too, on this fragment that the medial tibial spine is high and has a roughened non-articular surface and that the anterior-lateral margin of the articular surface on the medial condyle has a higher bony rampart than is seen in modern tibiae.

The shafts are robust. The least circumference in the right bone measures 54 mm. (53 mm. in the left). If we take the total length of the right tibia as 248 mm., then the index of robusticity is 21·8, the same as in the tall man, Skhūl V.

As to the flexure of the proximal end of the tibia, we can make no estimate, but the part which is preserved, representing at least two-thirds of the total length, is remarkably straight. Measurements of the anterior and posterior curvatures are given in Fig. 236 D. The anterior curvature has a chord of 135 mm., a subtense of 3 mm., giving a small ratio, 2·2; the posterior chord measures 162 mm., its subtense 6 mm., the ratio of the one to the other, 3·7.

A glance at the profile drawings of femur and tibia (Fig. 236 B, D) brings to light an interesting fact. The anterior curvature is greatest in the proximal half of both bones, while the posterior curvature reaches its height in the distal halves.

In this tibia are foreshadowed the characters we met with in the tibia of Skhūl V. It is of the Skhūl type, modern characters predominating over those of a Neanderthal nature.

Fibula. Of the right fibula we have only a fragment from the middle part of the shaft, measuring 70 mm. Of the left fibula we have four parts, totalling 200 mm. in length. Both proximal (Fig. 238 A) and distal (Fig. 238 B) ends of the diaphysis are preserved; to the distal end of the latter the epiphysis is still adherent. The part of the left shaft which is missing lies proximal to the part shown in Fig. 238 B and must have measured a little over 40 mm. in length.

The total length of the fibula was probably about 245 mm. The least circumference, which, as is usual, lies a short distance distal to the head, measures only 19 mm., giving an index of robusticity of 0·77. Perhaps it is more reasonable to take the circumference at mid-point of the shaft; it measures in this case 26 mm., giving an index of 1·06, the ratio found in the fibula of modern native races, such as Bushman and Australian.

In Fig. 238 *y* we give a section near the mid-point of the shaft; it is seen to be four-sided, the diameters being 8 mm. (a-p.), 9 mm. (m-l.).

The proximal end of the shaft is worthy of note (Fig. 238 A). It is three-sided, almost up to the head of the bone. The surfaces are lateral, medial, and posterior; the anterior border represents both anterior and interosseous margins. These are separated lower down (Fig. 238 A, *y*). The distal end of the fibula, forming the lateral malleolus of the ankle-joint, is depicted in Fig. 238 B. Relatively to the rest of the diaphysis the distal end is

massive, its a-p. diameter being 18·5 mm., its m-l. 11 mm. The length of the epiphysis from base to apex is 15 mm. The articular surface for the talus measures 12 mm. (a-p.) at its base; its length is 15 mm., its distal part being convex in the direction of its length.

The Foot.

Talus. The area of the talus, with which the left lateral malleolus articulates, is shown in Fig. 238 D. It gives the impression of being more massive than in modern bones; its height from base to apex is 24 mm.; the width of its base, measured by calipers on the border of the trochlea, is 22·2 mm.

There is only a slight groove to correspond with the apical convexity of the malleolus. Nor is there a splaying out of this surface as in the Neanderthalian talus; the apex of the area extends laterally only 3 mm. beyond the trochlear plane. This plane is represented by the medial and lateral borders of the trochlea of which the medial is 1·5 mm. higher than the lateral, when the bone rests on its lower surface on a flat plane.

Nor is the lateral articular (malleolar) triangle large when we work out the rates which its diameters bear to the length and width of the talus. In short, the characters seen on the lateral aspect of the body of the talus are those seen in the talus of modern native races.

The length (Martin 1) of the right talus is 39·5 mm., its width (Martin 2) 25·5 mm., its height (Martin 3) 21·5 mm. The proportion of width to length is 64·5 per cent., a very narrow bone, whereas the Neanderthal is short and wide with a width ratio of 87 per cent. In adult Europeans the mean ratio is 73·7. The height–length ratio in Skhūl VIII is 57 per cent., which is relatively higher than in adult Europeans (53·8) but lower than in the Neanderthal talus (61 per cent.).

The dimensions are Neanthropic and this character is supported by its anatomical features. The only primitive point is the extent to which the trochlear surface for the medial malleolus extends on the neck in front of the anterior border of the trochlea (mid-point); its projection is 9·5 mm., indicating a habit of squatting with the dorsum of the foot at an acute angle to the front of the tibia; a contact facet is seen on the lower epiphysis of the tibia. The length of the trochlear surface to its anterior mid-point is 22 mm., its greatest width 23 mm. The pre-trochlear surface (including head and neck) measures 17·5 mm., measured in the long diameter of the bone.

The head is remarkable. Its longest diameter, which rises upwards and outwards from the flat plane on which the talus is allowed to rest, forming an angle of 58° with the horizontal plane, measures (by calipers) 24 mm.; its greatest diameter, at right-angles to the long diameter, 13 mm. The head is massive and its long axis is nearer to the vertical than is usual. We infer that in walking the foot could be turned into a more *everted* position than is usual in modern races. The medial border of the trochlea is the higher, which indicated that the usual posture was one of inversion, not eversion.

On the lower surface of the head are articular areas for contact with the spring ligament and with the sustentaculum. On the under surface of the body we see that the two articular surfaces are united by a ridge at their adjoining medial borders. As will be seen from our drawings (Fig. 238 C, D, and Fig. 239 B) the head of the bone is big in comparison with the body, and its upper margin rises high above the level of the neck. The

lateral margin of the neck forms a sharp border. The angle which the axis of the neck forms with the axis of the trochlea is not remarkable (see Fig. 239 A); this angle measures 20°, a value near to the mean for modern races.

In connexion with the talus of the Tabūn woman (p. 22) we described a deep or sharply cut excavation on the under surface of the bone; this is also present in Skhūl VIII. It is situated at the anterior extremity of the interosseous area, behind and below the lateral part of the head.

In its main characters the talus of Skhūl VIII is Neanthropic, although there are points, such as the last named, which suggest Neanderthal affinities.

Calcaneus (*Os calcis*). Neither bone is complete; as may be seen from Fig. 238 C, the medial aspect of the right calcaneus is approximately complete; the amount preserved of the left bone is shown in Fig. 238 D. Only two parts are completely missing, these being the lateral tuberosity of the heel and the upper margin behind the talus (Fig. 238 *h*).

In dealing with the feet of the adults we found that the calcaneus of the Palestinian people was modelled on modern lines. All the features we meet with in the calcaneus of Skhūl VIII are also Neanthropic.

The length of the calcaneus (Martin 1) is 53·5 mm.; its width (Martin 2) 31·5 mm.; its estimated height (Martin 4) 29 mm. The ratio of width to length is 58·8 (modern bones are usually above 50 and under 60); the ratio of height to length is 54·7, which is three units above the mean for modern Europeans, but within the modern range. The calcaneus in Skhūl VIII is high and the heel stout.

Of the total length of the calcaneus (53·5 mm.), 21 mm. lies behind the talus and therefore represents 'length of the heel'. The heel in Skhūl VIII makes up 39·2 per cent. of the length of the calcaneus; if our estimate for total length of foot be accepted, namely, 165 mm., then the heel forms 12·7 per cent. of the foot length. We found the heel length in the Tabūn woman and in Skhūl IV to be short and stout as in Europeans; it is also so in this boy.

The articular surface for the cuboid is also preserved. Its shape is shown in Fig. 238 F; it is remarkably convex, both transversely and vertically.

The sustentaculum tali is wide and thick (7·8 mm.). The posterior articular surface is lost in the right bone and cannot be exposed on the left.

Navicular. That of the right foot is less perfect than that of the left, hence we shall confine our description to the latter. As will be seen from Fig. 238 D, the left navicular is cemented to the articular face of the head of the talus in a position of moderate inversion (Fig. 238 F). Views of it are also given in Figs. 239 A, B. The medial part, carrying the tuberosity, is damaged. The total width of its articular surface for the head of the talus we estimate to have been 23 mm.; the long axis of the articular surface of the talus, measured not by calipers but by tape, 33 mm., gives a surface for play of 10 mm. The maximum transverse diameter of the bone, including the tuberosity, was about 26 mm.; its maximum height (d-v. diameter), 18 mm., its thickness (proximo-distal diameter), 10 mm. (8·2 mm. on the right bone).

The most instructive view is that depicted in Fig. 238 F, where the articular surfaces for the cuneiform bones are depicted and compared with a corresponding view of the navicular of a modern bone, that of a Bushman (Fig. 238 E). It will be seen that the chief difference relates to the area which receives the internal cuneiform. In the fossil bone

this surface is set very obliquely, whereas in the Bushman it is situated more vertically and is more expanded at its plantar end. From which we infer that the foot was held in a more inverted position than in the Bushman, and, as we shall see, the metatarsal part of the left foot, when brought into articulation with the navicular in its present position, assumes a strongly inverted position.

In Fig. 239 A is shown a dorsal view of the left foot. The bones of this foot are cemented together so as to form two pieces, the division between the two having been made distal to the navicular bone. In Fig. 239 A the two pieces are in natural apposition, or rather they articulate in the position occupied by the foot at the time of burial. The foot must have been strongly inverted for as poised in Figs. 239 A, B, the dorsal border of the base of the second metatarsal is 30 mm. above the plane on which the foot rests, while the base of the fifth is only 11 mm. above the plane. The arch formed by the base of the metatarsals rises up, from fifth to second, at an angle of 24° with the plane on which the foot rests. No doubt the foot was more inverted after death than was habitually the case when the boy was alive. Nevertheless, the articular markings of the tarsus indicates a tendency to walk on the lateral margin of the foot.

Cuneiforms. Of the three cuneiforms, only the middle (II) and lateral (III) are almost complete. The chief measurements made on the dorsal aspect of cuneiform II are 13·5 (a-p.), 12·0 (m-l.), 12·5 (d-v.). Cuneiform III is slightly wider than the cuneiform II and is longer. Measurements made as in the last are 17·6 (a-p.), 11·3 (m-l.), 14·0 (d-v.). As to cuneiform I, much is lacking (see Fig. 239 A, B), but its distal facet for metatarsal I is preserved. It is difficult to make an exact measurement of the angle which this surface forms with the medial margin of the foot; our measurement gives an angle of 15°, the face for the first metatarsal being directed forwards and 15° inwards (medially), an angle met with in the corresponding joint of native peoples.

As will be seen from Fig. 239 A, the left foot has been crushed at some time subsequent to burial. The first metatarsal has been broken and forced outwards against the basis of the other metatarsals, cuneiform I being also involved in the outward movement.

Cuboid. The plantar surface and the lateral margin are lost, but as will be seen from Fig. 239 A, *q*, most of the dorsal surface is preserved. So is the proximal surface for articulation with the calcaneus. This surface is strongly convex from side to side and slightly concave in a dorso-plantar direction. It sends the usual projection backwards under the calcaneal articulation. The medial margin of the dorsal surface measures 20 mm. in an a-p. direction, while near the lateral margin the a-p. diameter is 14 mm. In the cuboid of an English child of approximately the same age, the corresponding diameters are 21 and 15 mm. respectively. The medial surface made a wide contact with the navicular. The English cuboid is wider and more massive, but we can see no important structural feature of difference.

Metatarsals. The state of these bones will be seen from Fig. 239 A; only the metatarsals IV and V retain their distal epiphyses. In calculating the total length of metatarsals II and III, 5 mm. have been allowed for the missing distal epiphysis. The various lengths and diameters are given in Table LXXXVI, p. 344. The first metatarsal is similar in its length and strength to that of the English child's foot, save that the d-v. diameter of its distal end (head) is greater. It is nearly 10 mm. shorter than either metatarsals II or III, a proportion met with in the feet of modern children. The entire series of metatarsals is

strongly built. The second toe was evidently the longest of the series, while the third toe was apparently next to it in length.

There are only two phalanges, the proximal of the first and of the second toes. Both of these are of about equal length—18 mm., but that of the first has a wide base—12 mm., against 6 mm. in that of the second toe. These phalanges are shown in Fig. 239 A; their proximal epiphyses are un-united.

The Foot as a Whole. The foot, as restored in Fig. 239 A, B, is 150 mm. long; we may add 15 mm. for the missing phalanges of the second toe, giving a total length of 165 mm. This represents 66·5 per cent. of the estimated tibia length, a relatively long foot. Of the total length the tarsus makes up 82 mm. (nearly 50 per cent.), the metatarsus (II), 52 mm. (31·5 per cent.); phalanges the remaining 18·5 per cent. There is nothing exceptional in these estimates. The estimated width of tarsus, measured between the medial margin of cuneiform I, just behind the joint for the first metatarsal and the position of the cuboid immediately behind the fifth metatarsal is 42 mm., which represents 63·4 per cent. of the tarsal length and 23 per cent. of the total foot. The foot was narrow in respect of its length. The foot of the English child used for comparison is 170 mm. long, its tarsal width being 46 mm. The proportion of width to length is 27 per cent., a stouter and wider foot than that of the Carmel boy.

In Fig. 239 B a view of the foot is given as seen in profile on its medial aspect; we have noted that the bases of metatarsals form a high arch; the transverse arch of the foot was well developed. The longitudinal arch is represented in our drawing and is similar in form and height to that found in the feet of European boys of an age corresponding to Skhūl VIII.

Our survey of the fossil remains of the boy known as Skhūl VIII, and estimated to have been about 8 years of age and nearly 47 inches (1,190 mm.) in height, has impressed us, not with his differences from, but with his resemblances to modern boys. And yet, in every bone we have detected some features which have a Palaeanthropic (Neanderthalian) character.

Table LXXXIV. IMMATURE FIRST SACRAL VERTEBRA

	Skhūl I	*English child*	*Peruvian child*
Width:			
centrum*	52·0	63·0	54·0
body†	48·0	60·0	51·0
maximum‡	25·5	29·0	27·2
between transverse elements of lateral mass§	31·0	37·0	32·0
maximum bi-articular	36·0	43·0	41·0
Dorso-ventral diameter of cranial aspect of body	13·0	15·5	13·0
Height of mid-point:			
anterior surface	12·0	12·2	12·0
posterior surface	10·0	10·0	10·0

* Fig. 234 A, *c*. ‡ Fig. 234 A, *a–a*.
† Fig. 234 A, *d*. § Fig. 234 A, *b-b*.

Table LXXXV. DIMENSIONS OF FIRST RIGHT METATARSAL

	Carmel	*No. 1009 (Peru)*
Total length M1	26·5	25·0
Corpus:		
breadth M3	8·0	7·2
height M4	8·2	6·6
Base:		
width M6	10·0	9·2
height M7	14·0	(10·5)
Head:		
width M8	9·2	10·0
height M9	10·2	9·5

Table LXXXVI. METATARSALS OF SKHŪL VIII

	Metatarsals				
	I	*II*	*III*	*IV*	*V*
Length:					
diaphysis	37·0	47·0	46·0	47·0	48·0
diaphysis and epiphysis	42·5	52·0	51·0	51·0	43·5
Diameters of Base:					
dorso-ventral	8·2	13·0	13·5	..	9·5
medio-lateral	13·2	10·0	9·7	9·0	11·0
Mid-shaft diameters:					
dorso-ventral	10·6	6·2	8·0	8·6	5·0
medio-lateral	9·0	5·2	6·4	5·3	7·3

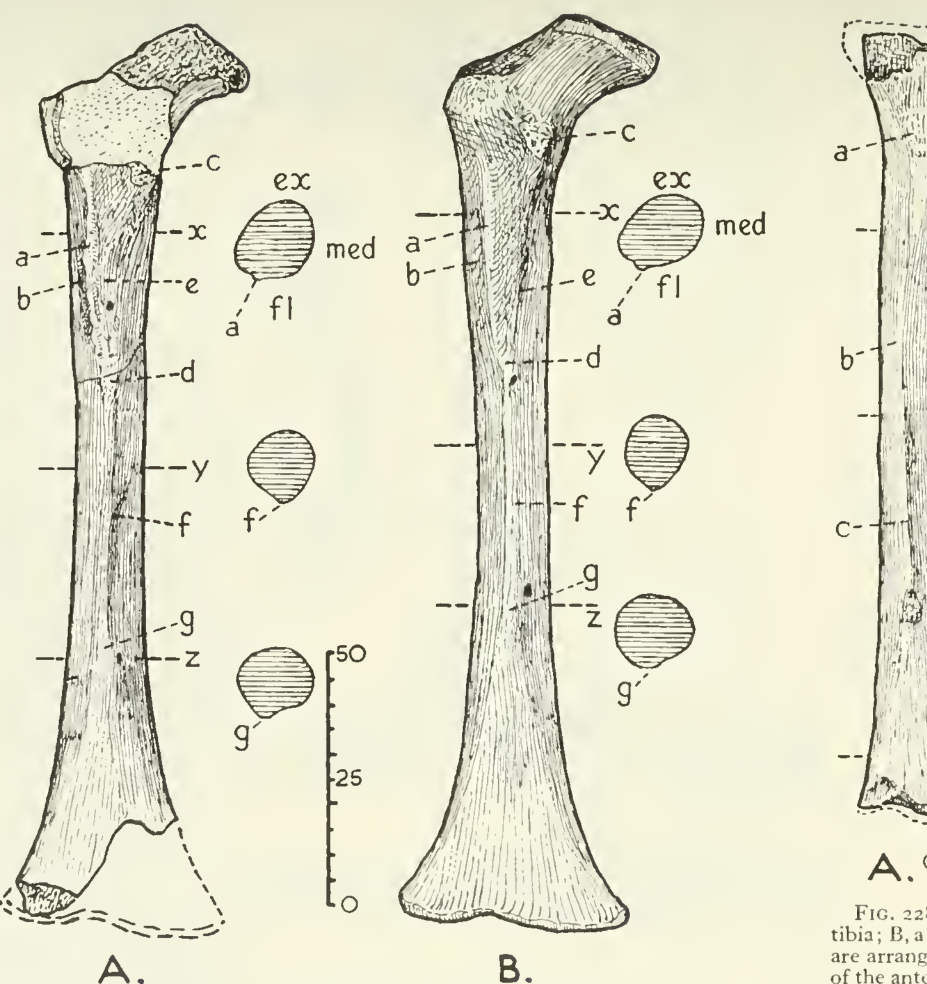


FIG. 227. A, flexor aspect of the left femoral diaphysis of the Carmel child. B, similar view of the diaphysis of an English (medieval) child. *x*, *y*, *z*, points at which transverse sectional outlines were made—the sectional outlines being placed opposite the sites, the extensor (*ex*) surface heing placed above, the flexor (*fl*) below the medial (*med*) away from the main drawing. *a*, gluteal ridge; *b*, gluteal impression; *c*, trochanter minor; *d*, proximal end of the linea aspera; *e*, upper medial bifurcation; *f*, near midpoint of linea; *g*, distal end of linea aspera.

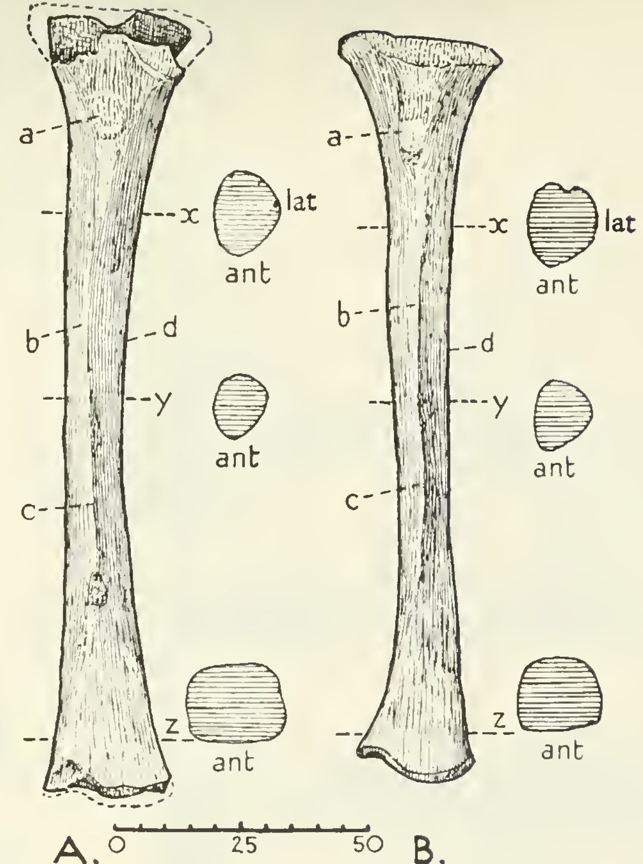


FIG. 228. A, drawing of anterior view of the Carmel child's left tibia; B, a corresponding view of an English child's tibia. The shafts are arranged on a vertical plane which descends from the midpoint of the anterior tuberosity (area for insertion of quadriceps) to a point on the distal end, midway between mediai and lateral borders. The shafts have been placed so as to present about equal extents of the two anterior surfaces—medial and lateral—separated by the tibial crest. Three sectional outlines are shown—*x*, at the level of the nutrient foramen; *y*, at midpoint, *z*, 12 mm. above distal end of diaphysis. *a*, anterior tuberosity (area for insertion); *b*, tibial crest in its upper segment; *c*, in its lower segment; *d*, lateral border. *lat*, lateral side; *ant*, anterior or extensor surface.

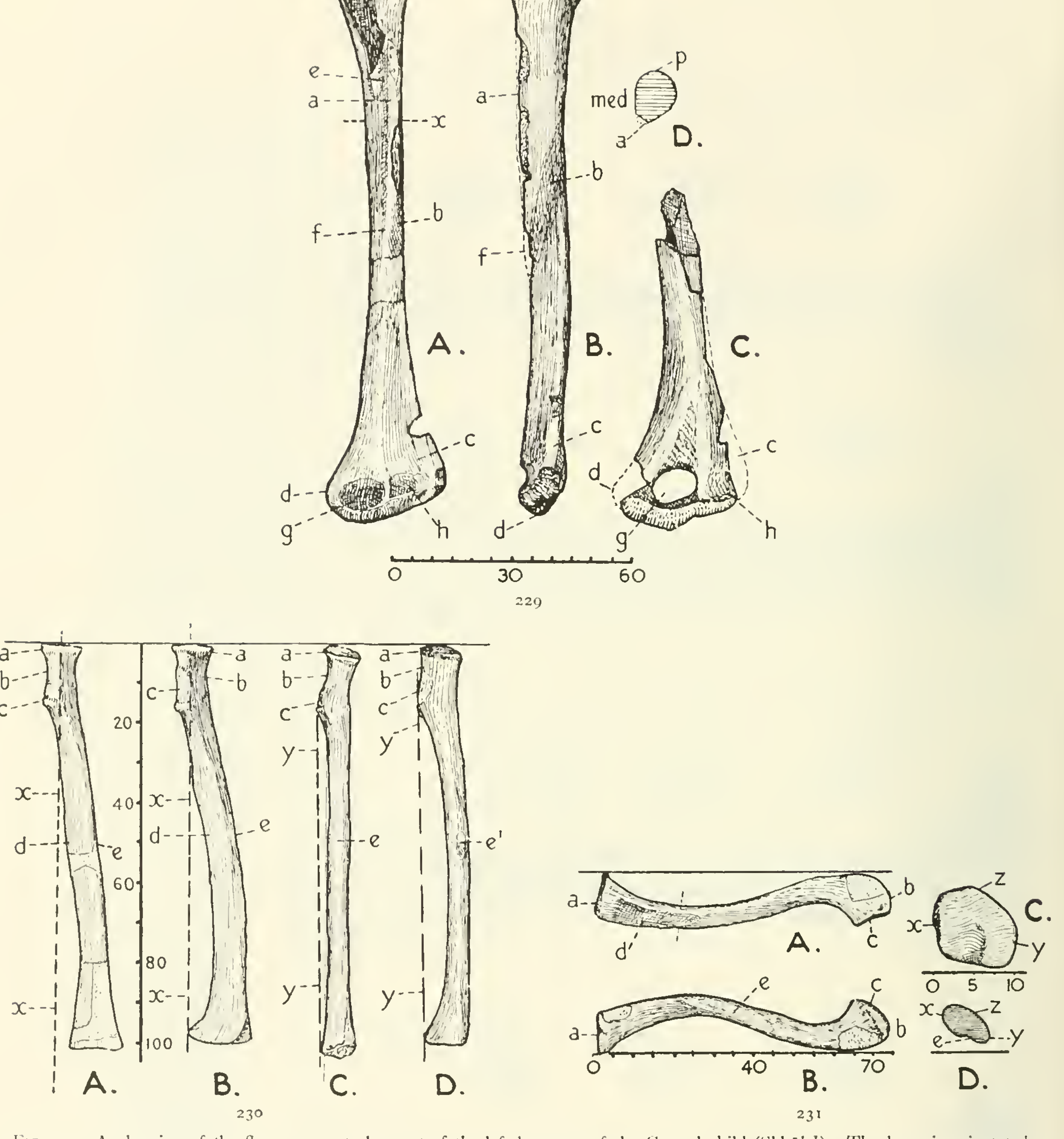


FIG. 229. A, drawing of the flexor or ventral aspect of the left humerus of the Carmel child (Skhūl I). The bone is orientated on a vertical sagittal plane which passes down the centre of the shaft; the transverse axis of its distal part is at right angles to the sagittal plane. B, view of the radial aspect, drawn at right angles to A. C, flexor aspect of the distal end of the right humerus of the child, Skhūl X, about a year older than Skhūl I. The drawing has been reversed so as to make possible a direct comparison with the distal end of the left humerus of Skhūl I. D, section of the left humerus of Skhūl I, made at the point indicated in A, *x*. *a*, pectoral ridge; *b*, groove for radial nerve; *c*, lateral epicondylar border; *d*, medial border; *e*, lower end of latissimus insertion; *f*, deltoid ridge and impression; *g*, coronoid fossa (perforated in C); *h*, radial fossa; *med*, medial surface; *p*, exterior or tricipital surface.

FIG. 230. A, volar view of the left radius of the Carmel child. The broken line, *x–x*, continues the axis of the neck. The aspect is not purely volar or ventral; the bone was turned from a supine position towards a prone one until the neck made its maximum angle with the proximal axis of the shaft. To reach this, the radius was rotated about 20° from the supine position. B, similar view of the radius of an English (medieval) child of the same dental age. C, the Carmel radius seen in lateral profile, the shaft being turned away from the purely supine position until the neck made its maximus angle with the shaft of the bone (about 20° prone). D, similar view of the English specimen. *y–y*, line joining bicipital tuberosity to projecting volar margin at distal end. This margin is missing in the Carmel radius. *a*, head; *b*, neck; *c*, bicipital tuberosity; *d*, medial (interosseus) border; *e*, lateral border. In D, *e′* indicates the insertion of pronator teres.

FIG. 231. A, the left clavicle of the Carmel child viewed from above. B, seen from below. C, the sternal (articular) end of the clavicle (*x*2). D, section made at site indicated in A. In all of these drawings the acromial end was placed in a horizontal plane; this plane is indicated in C and D. *a*, sternal end of clavicle; *b*, acromial end; *c*, acromio-clavicular articulation; *d*, area of origin of clavicular head of pectoralis major; *e*, insertion of subclavicus; *x*, dorsal border or surface; *y*, ventral border or surface; *z*, upper or cranial surface.

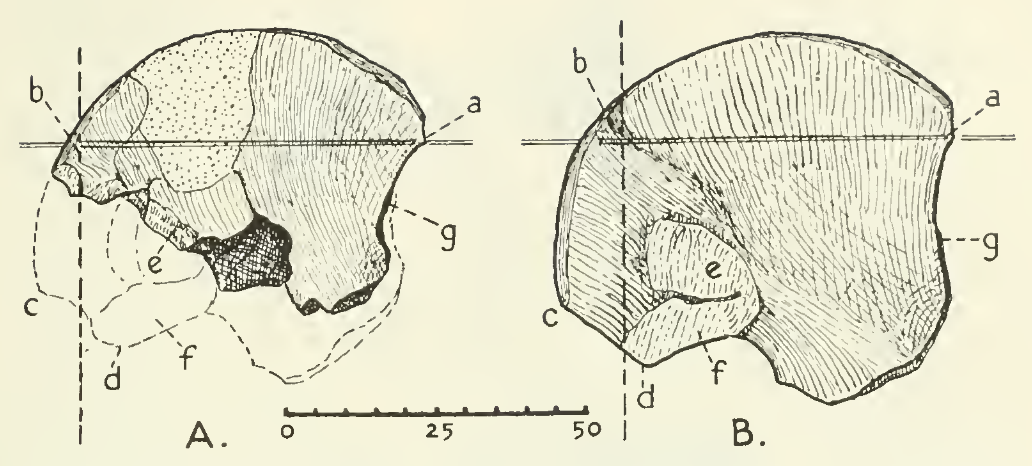


FIG. 232. A, medial or visceral aspect of the Carmel child's left ilium. The parts missing are stippled. B, similar view of the ilium of an English child of like age. Both are orientated on the same horizontal plane—one which passes through the anterior superior iliac spine (*a*) in front and the retro-iliac tuberosity (*b*) behind. *a*, anterior superior iliac spine; *b*, retro-iliac tuberosity; *c*, posterior superior spine; *d*, posterior inferior iliac spine; *e*, part of the ventral margin of sacral articulation; *f*, horizontal part of sacro-iliac articular surface; *g*, site of anterior inferior iliac spine.

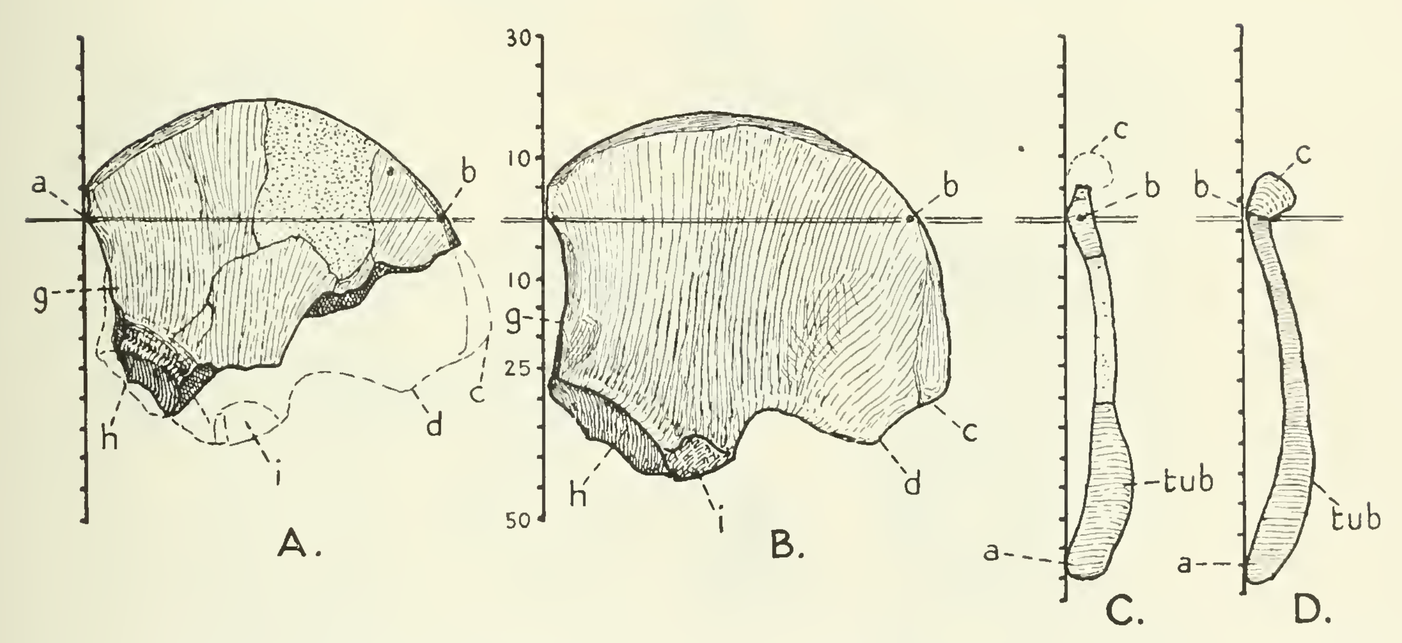


FIG. 233. A, lateral view of the ilium of the Carmel child; B, of a modern English child. Orientation and lettering as in Fig. 232. *h*, upper margin of acetabular cavity; *i*, for union with ischium; C, crest of ilium of Carmel child drawn at right angles to the plane shown in Fig. 233 A. D, crest of ilium of English child drawn as in C. *tub*, site of tuberosity of crest.

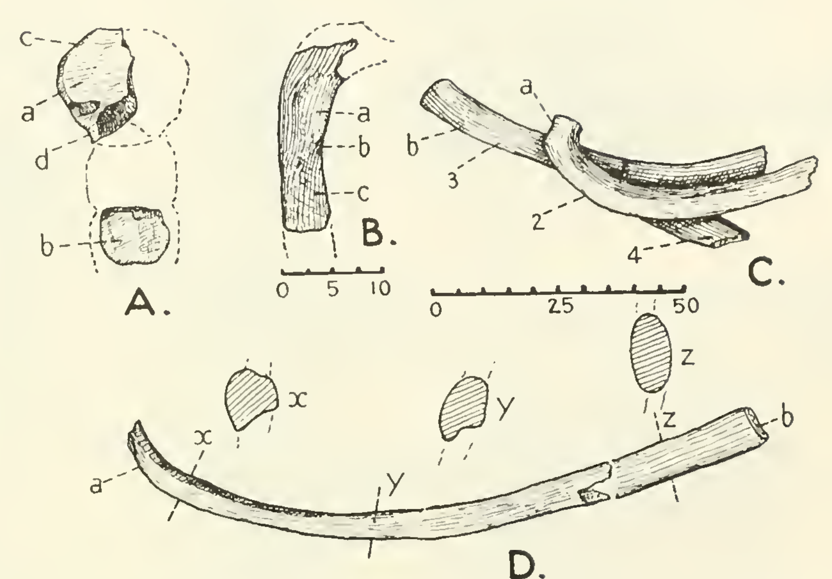


Fig. 234. A, upper aspect of the first sacral vertebra of an English child of the same dental age as the Carmel child. B, the same aspect of the first sacral of the Carmel child. C, the same of a Peruvian child but younger in point of development than the Carmel child. D, upper (cranial) surface of first lumbar vertebra of Carmel child. E, same of Peruvian child. F, left lateral view of first lumbar of Carmel child. G, same of Peruvian child. H, first Dorsal vertebra of Carmel child, upper or cranial aspect. J, same of Peruvian child. *s*, spinous process; *p*, pedicle; *nc*, neuro-central line of union. *a*, *a*, points on the costal element of the lateral mass between which the sacral width is measured; *b*, *b*, points on the transverse element of the lateral mass, sites of measurement *b*; *c*, measurement of width of central element; *d*, measurement of body width; *e*, upper articular process; *f*, sacral lamina.

Fig. 235. A, drawing of the sternal fragments of the Carmel child. *a*, right half of manubrium; *b*, second or third segment of mesosternum; *c*, clavicular area of margin; *d*, notch for second rib. B, fragment of the first rib enlarged to twice natural size. The drawing was made from the left rib and reversed. *a*, raised area for insertion of scalenus medius; *b*, groove for first dorsal nerve; *c*, groove for subclavian vessel. C, second, third, and fourth ribs of right side. *a*, neck of second rib; *b*, angle of third rib. D, Craniolateral view of seventh rib with sections *x*, *y*, *z*, made at sites indicated. The ventral part of the rib is taken from the corresponding member of the left side. *a*, angle; *b*, sternal end.

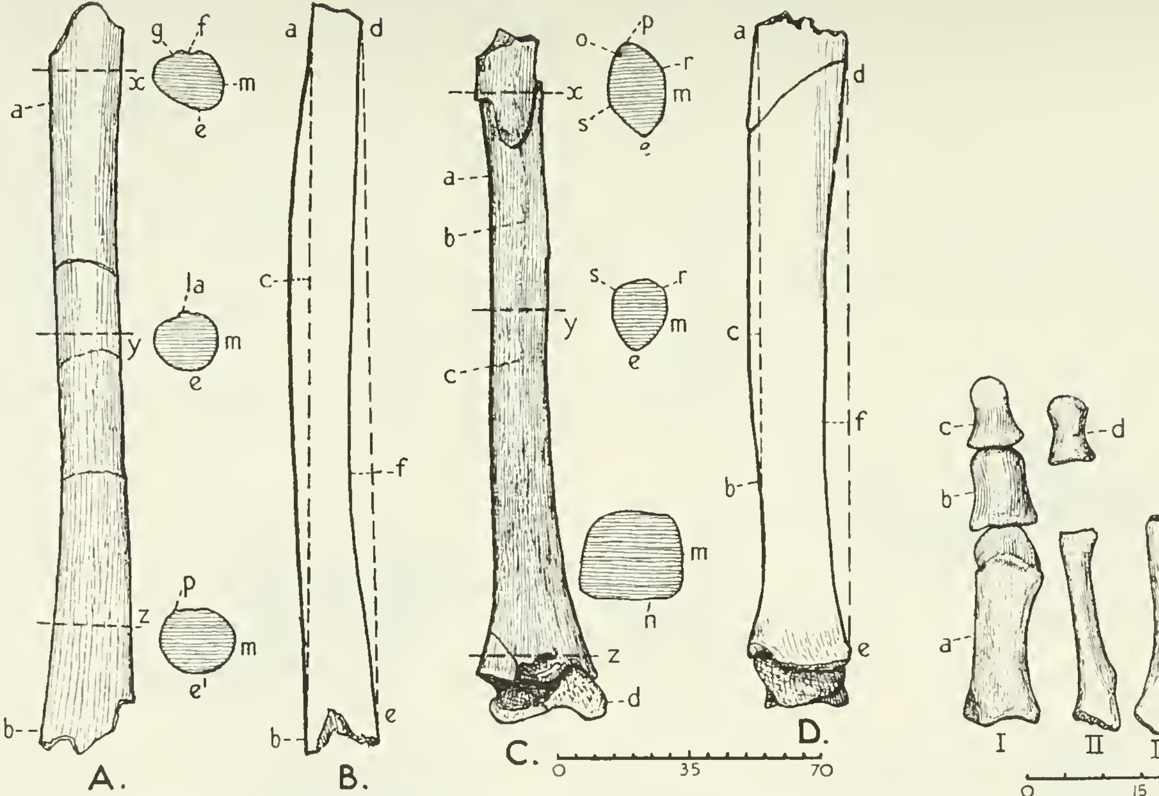


FIG. 236. A, anterior view of the shaft of the right femur of Skhūl VIII. *x*, *y*, *z*, mark the sites of the adjacent sections. B, medial view. *a*, lateral border in region of gluteal impression; *b*, lateral border near midpoint of the popliteal region; *e*, anterior or extensor margin of sections; *m*, medial margin; *g*, gluteal impression; *f*, impression medial to gluteal ridge; *la*, linea aspera; *p*, lateral division of linea aspera; *a*, *b*, points on anterior surface at which chord of anterior curvature ends; *c*, subtense; *d*, *e*, points at which posterior chord ends; *f*, subtense. C, anterior view of shaft of right tibia of Skhūl VIII. *x*, site of upper section made at nutrient foramen; *y*, site of mid-section; *z*, site of lower section; *a*, lateral (interosseus) border; *b*, anterior border or crest (concave segment); *c*, crest, lower or straight segment; *m*, medial margin of section; *e*, anterior border; *p*, oblique popliteal ridge; *s*, interosseus margin; *o*, nutrient foramen; *r*, medial margin; *n*, anterior surface in distal segment. D, medial view of right tibial shaft. *a*, *b*, points on anterior border at which anterior chord ends; *c*, subtense; *d*, *e*, points at which posterior chord ends; *f*, subtense.

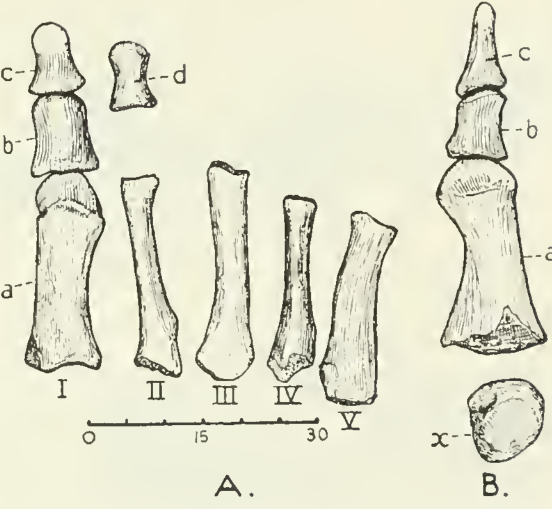


FIG. 237. A, metatarsi of right foot of Skhūl I, viewed on their dorsal aspect. The proximal extremities of the metatarsal bones are damaged in all cases. Two phalanges of the great toe and one of another (second) toe are included. B, medial view of the bones of the great toe and of the entocuneiform. *a*, first metatarsal; *b*, proximal phalanx of great toe; *c*, distal phalanx; *d*, phalanx, probably the proximal of the second toe. *x*, medial view of the entocuneiform in its natural relationship to first metatarsal.

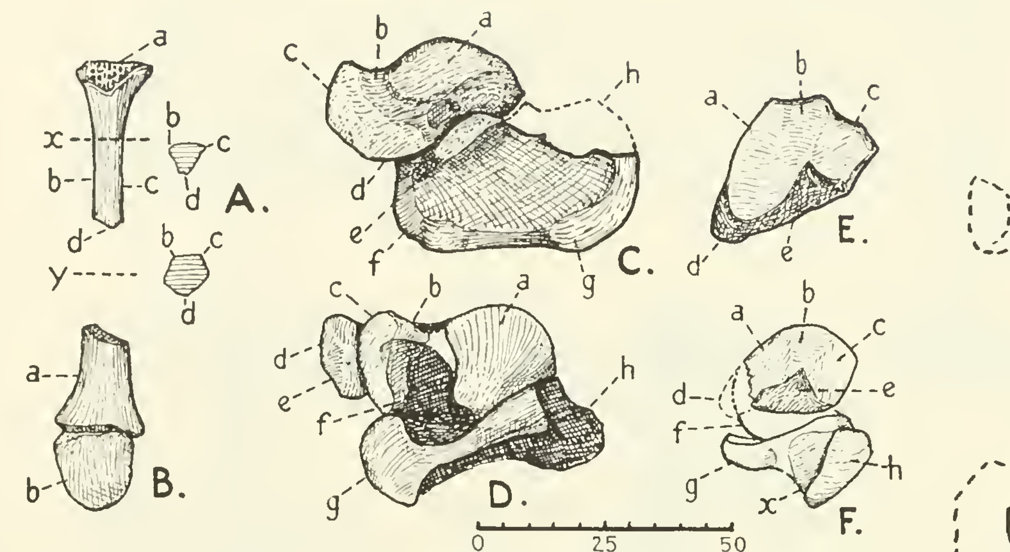


Fig. 238. Skhūl VIII. A, proximal end of left fibula viewed anteriorly. *x*, site of section shown in adjacent drawing; *y*, is a section near midpoint of fibula; *a*, epiphysial line of head; *b*, medial border; *c*, lateral border; *d*, anterior margin; *d′*, interosseus border. B, distal fragment of fibula viewed laterally. *a*, anterior border of diaphysis; *b*, anterior border of epiphysis. C, medial aspect of the talus and calcaneus of the right foot. *a*, surface for medial malleolus; *b*, neck; *c*, navicular articular surface; *d*, surface for supporting ligament; *e*, sustentaculum tali; *f*, articular surface for cuboid; *g*, medial tuberosity of heel; *h*, estimated height of calcaneal heel. D, lateral aspect of talus, calcaneus and navicular of left foot. *a*, surface for lateral malleolus; *b*, neck—the lateral margin (broken) being narrow; *c*, articular surface for navicular (exposed); *d*, articular surface on navicular for cuneiform II; *e*, for cuneiform III; *f*, large recess due to erosion; *g*, surface on calcaneus for cuboid; *h*, eroded area of calcaneus. E, distal surface of the navicular of a Bushman (left). F, corresponding view of navicular of the left foot of Skhūl VIII, the head of the talus and the distal aspect of the os calcis being also indicated. The part carrying the tuberosity, which has been broken away, is indicated by a broken line. *a*, area for cuneiform I; *b*, for cuneiform II; *c*, for cuneiform III; *d*, tuberosity; *e*, ligamentous area; *f*, head of talus; *g*, sustentaculum tali; *h*, cuboidal facet on calcaneus; *x*, a fissure where some displacement has taken place.

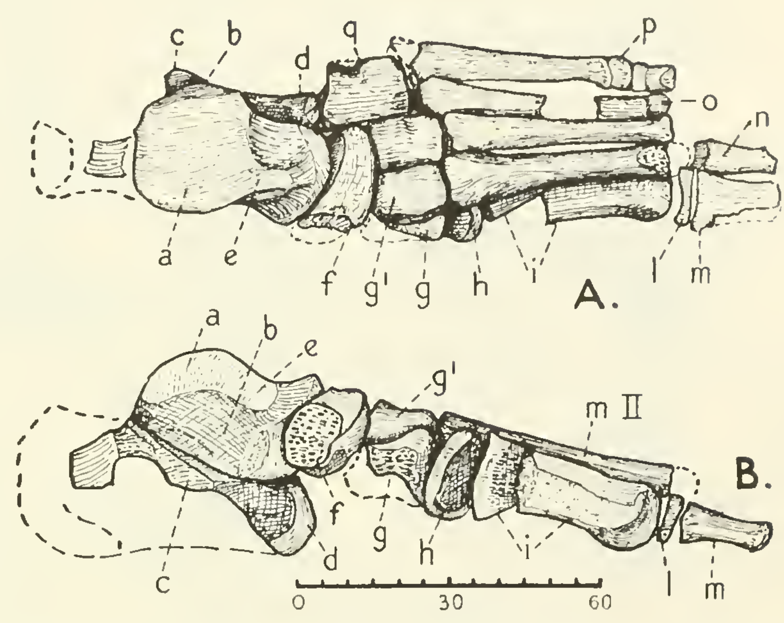


Fig. 239. A, dorsal view of the left foot of the Skhūl boy, Skhūl VIII; the upper surface of the talus has been copied from the right bone. The foot is orientated so as to bring the margins of the trochlea to the same level. *a*, trochlea; *b*, lateral malleolar surface; *c*, calcaneus; *d*, distal end of calcaneus; *e*, medial malleolar extension; *f*, navicular with medial end broken; *g*, cuneiform I; *g*, cuneiform II; *h*, proximal epiphysis of metatarsal I; *i*, broken metatarsal I; *l*, proximal epiphysis of proximal phalanx of great toe; *m*, phalanx; *r*, proximal phalanx of second toe; *o*, distal epiphysis of fourth metatarsal; *p*, same of fifth; *q*, cuboid. B, medial view of left foot of the Skhūl boy. Outline of calcaneus copied from right bone and indicated by broken line. *a*, medial maleolar surface of talus; *b*, crushed and expanded body of talus; *c*, sustentaculum tali (broken and exposed); other letters as in Fig. 239 A.

CHAPTER XXI

THE BRAIN, AS REFLECTED IN THE ENDOCRANIAL CAST

SKHŪL I (Pls. XXIV, XXV)

WE applied a Pearsonian formula to the chief diameters of the cranium of the Carmel child and obtained an estimated capacity of 1,140 c.c. (Table LXXIII, p. 295), while the same formula applied to the skull of a Negro child, which we used for purposes of comparison, gave a capacity of 1,152 c.c. Mr. F. O. Barlow made endocranial casts of both of these skulls; that of the Carmel child displaced 1,106 c.c. of water, but in restoring the missing basal parts we feel certain that the allowance made by copying these from the Negro skull is insufficient and that a full restoration would give a displacement of 1,150 c.c. We accept the latter estimate, 1,150 c.c., as representing the cranial capacity of the Carmel child's skull. The endocranium of the Negro child's skull displaced 1,223 c.c. of water.

Now, from the measurements made by Berry and Porteous (1928) on the heads of living children born to Europeans in Australia, and by the application of a Pearsonian formula to these measurements, we obtain the information that at the age of three and a half years a white child (boy) has, in the mean, a cranial capacity of 1,170 c.c. If the age and sex which we have assigned to the Carmel child are right, then in brain capacity this child fell only 20 c.c. short of the mean for modern white children. At this age the brain has attained about 79 per cent. of its full size; on such a basis the Carmel child, had he lived, would likely have attained a cranial capacity of about 1,450 c.c. In the Skhūl males, whose cranial capacities have been estimated, the amount ranged from 1,518 to 1,587 c.c.

Measurements of the Cast.[1]

When giving measurements of the skull of Skhūl I we mentioned that the length of the cranial cavity was 163 mm., its width 116 mm., and the height of the vault above the Frankfort plane 104 mm. The cast prepared by Mr. Barlow is unequal in the length of its two hemispheres. The right hemisphere, measured from frontal to occipital pole, gives it a length of 167 mm., the left 163 mm. The greater length of the right side is due to a displacement forwards of the right frontal of the skull; the true length is that of the left side. The bi-parietal width of the cast is 116 mm., the width being 71·1 per cent. of the length. The Negro cast has a length of 167 mm., its greater length being due chiefly to the attenuation and projection of the occipital poles; its width is 117 mm., the width being 70 per cent. of its length. As in many endocranial casts taken from modern

[1] We take this opportunity of acknowledging our indebtedness to the writings of Dr. Ariëns Kappers, particularly two recent papers: 'The Fissuration of the Frontal Lobe of Sinanthropus compared with the Fissuration in Neanderthal Men', *Proc. Konin. Akad. v. Wetensch. te Amsterdam*, 1933, vol. xxxvi, p. 802; 'Some Features of the Parietal and Temporal Lobes of the Human Brain and their Morphological Significance' (with Dr. Wang Hwei-Wen), *China Medical Journal*, 1924, September. Also to Dr. Franz Weidenreich's 'Observations on the Form and Proportions of the Endocranial Casts of Sinanthropus Pekinensis, other Homids and Great Apes', *Palaeontologica Sinica*, 1936, Series D, vol. vii, fascicle 4.

skulls, the right frontal lobe in the Negro cast projects in front of the left (1·5 mm.), while the left occipital pole projects 2 mm. beyond the right; in the Carmel cast the projection of the two occipital poles is equal, although the area of the left is more extensive than that of the right.

In Figs. 240, 242 we have placed the endocranial cast of the Carmel child on the same plane as we employed for the skull, namely, the Frankfort plane. Fortunately this plane corresponds, or nearly corresponds, in human skulls, to the deepest part of the temporal lobes of the brain and may therefore be employed as a base from which heights of the cerebrum are measured. The highest part of the parietal region of the cast rises 102 mm. above the Frankfort plane; in the Negro cast the corresponding measurement is 104 mm., but in the case of Skhūl I the deepest part of the temporal lobe descended only 3 mm. below the Frankfort plane; that of the Negro is 6 mm. below this plane. Although the total height of the Carmel cerebrum is less than that of the Negro child, yet, relative to the total length, the height falls within the range for Neanthropic man.

The height of the cerebral part of the endocranial cast was taken 30 mm. behind the position of the bregma, and at right-angles to the Frankfort plane. We noted the position which the Sylvian depression on the cast held to our vertical measurement, for we desired to ascertain if this landmark between the temporal and parietal lobes was variable or steadfast in the level occupied on the brain. For example, in the Negro cast, our vertical measurement crossed the Sylvian depression 49 mm. above the Frankfort plane; thus of the total height (104 mm.) 49 mm. (47·2 per cent.) lay opposite the temporal lobe and 55 mm. (52·8 per cent.) opposite the parietal lobe. On the left side of the Carmel cast the temporal segment of the vertical height measures 48 mm. (47·1 per cent.), the parietal 54 mm. (52·9 per cent.). The proportions are the same as in the Negro cast. But on the right side the Sylvian depression lies at a lower level; the temporal part of the vertical diameter is only 40 mm., the parietal 62 mm., the latter being 60·7 per cent. of the whole. It is the left side of the Carmel cast which gives the truest information concerning the position of the Sylvian fissure; on the right side this region is damaged and depressed. An endocranial cast from the skull of an Australian aborigine has a vertical measurement of 114 mm., of which 58·7 per cent. corresponded to the height of the parietal lobe. In the Gibraltar (adult) cast, representing the Neanderthal type, the total height is 103 mm., of which 53·4 per cent. is parietal. In a cast taken from the skull of a gorilla the parietal part of the vertical diameter measured only 42·1 per cent. of the whole. We were in hopes that in the proportions of temporal to parietal lobe we might find a mode of racial discrimination. In this we are disappointed, the individual variability being very great. Nevertheless, the agreement between the Negro and the Carmel endocranial cast is a point worthy of note.

In Fig. 240 a drawing is given of the left hemisphere of the Carmel cast, seen in profile and orientated on the Frankfort plane (F—P); in Fig. 241 a corresponding drawing is given of the cast taken from the skull of a Negro child, the specimen which served as a basis of comparison when describing the skull of the Carmel child. When these two drawings are superimposed an interesting difference is revealed. The poles of the occipital lobes of the Negro cast project beyond those of the Carmel cast; on the other hand, the Carmel cerebellar lobes project well behind those of the Negro. At the frontal end of the cast there is a similar misfit, the lower frontal areas projecting above and

beyond those of the Negro. We have here evidence that the Negro brain as a whole (and the same must hold true of the basi-cranial axis of the skull) is more bent or flexed than that of the Carmel child. In this the Carmel child is the more anthropoid.

Convolutions of the Frontal Region.

At the time we were preparing this part of our report, there appeared two important papers dealing with the topography of the brain. One of these, by Professor Le Gros Clark and two colleagues (1936), gives the results of the correspondence, or lack of correspondence, between the sulci and fissures of the actual brain and of the cast taken from the skull which contained it. They found that casts vary in the sharpness of their impressions, according to the individual skull, but even in the best, there were many which gave no precise information concerning the situation and form of important fissures and sulci. The late Professor Johnson Symington (1915) made similar observations on the relationship of human brains to their endocranial casts. His investigations were occasioned by the report which the late Sir Grafton Elliot Smith contributed to Sir Arthur Smith Woodward's monograph on the Piltdown skull. The other paper which has just come into our hands is Professor J. Shellshear's monograph (1937) on the brain of the Australian aborigine. He had forty-four hemispheres on which to base an account of the cerebral morphology of this race. In all parts of the brain he found a wide range of individual variation, particularly in the region we are now to describe—that of the third frontal gyrus. Dr. Joseph Shaw Bolton (1910) found the British brain equally variable in this region.

We agree with Symington and with Professor Le Gros Clark and his colleagues that endocranial casts give very imperfect indications of the fissures and of sulci of the brain. We would urge, however, that fissures and sulci are merely the frontiers of the territories of the brain; the actual territories are the convolutions, and we can depend on many of them being more faithfully represented on the casts than on the brains extracted from skulls by ordinary methods. After death the brain loses its living form just as the lungs do when the chest is opened. We agree with Professor Shellshear that the topography of a brain cannot be studied profitably unless it be accompanied by the endocranial cast of the skull in which the brain was contained.

For, if we look at the matter aright, the cranial wall is merely the living, sensitive, bony coat of the proper capsule of the brain, the dura mater. That bony coating is sensitive to and is moulded by all the constant pressures that are brought to bear upon it, within and without. It is a perfect record of the pressures exerted on it by intra-cranial contents. The endocranial cast records the attachments of the dura mater at its sutural lines and the blood channels, arterial and venous, which are embedded in the dura. The cast records subarachnoid pools and channels; these effectively mask all convolutions and sulci of the upper parietal region, and of the adjacent areas of the frontal and occipital regions. But they preserve the convolutionary pattern in four areas: (1) the lower frontal region, (2) the central parietal region, (3) the temporal region, (4) and often the region of the occipital poles. In respect of these four regions the endocranial cast of the Carmel child fulfils our expectations, save that the occipital region is remarkably smooth; certainly the convolutionary pattern in the Negro cast (Fig. 241) is more sharply marked and is more richly folded than that of the Carmel child.

Before examining that region of the third frontal gyrus, which forms the 'frontal cap',

it may be well to glance first at this region in the Negro cast (Fig. 241). The two chief convolutions of the cap we have indicated by the letters *a*, *b*; the pattern is a V-shaped one, two grooves descend downwards and backwards into the region of the cap and represent branches of the inferior frontal sulcus. Above *b* is another convolutionary eminence marked *c*; the groove which separates *c* from *b* we regard as an indication of the ascending ramus of the Sylvian fissure. *a* and *b* would, therefore, represent the pars triangularis, and *c* would belong to the pars frontalis of the opercular covering of the island. In front of *a* there is a notch on the orbital margin; this we regard as indicating the anterior end of the sulcus which Dr. Ariëns Kappers has named 'sub-frontal', but which one of us has always known as the fronto-orbital, believing it to correspond to that fissure of the anthropoid brain on the orbital margin; still farther forwards is another notch; it lies between the rostrum of the first frontal gyrus and the orbital margin of the second.

Above the cap and the region of the third gyrus are two other convolutionary eminences we have indicated by the letters *d*, *f*. Between them is a V-shaped depression which we regard as part of the middle frontal (arcuate) sulcus. The convolutions *d*, *f*, therefore, represent parts of the second or middle frontal gyrus. Higher up on the frontal part of the cast, convolutions and sulci are masked by the paramedian cistern of cerebro-spinal fluid.[1]

Turning now to the frontal region of the Carmel cast we note that the hinder part of the cap is missing, the part of the frontal bone which contained it having been broken away. Even if this missing part were restored it is plain that the cap was smaller and less richly convoluted than in the cast we are using as a basis of comparison. Anatomists will agree that the Negro child, which we have used for comparison because it was of about the same 'dental age' as the fossil child, had an exceptionally well developed third frontal region.

Turning again to the Carmel cast, it will be noted that convolutions and sulci follow a more horizontal direction than in the Negro cast. Above *b* we have indicated a neighbouring convolution by *c*; this may or may not correspond to *c* in the Negro cast. Above *c* follow three other convolutionary eminences, *d*, *e*, *f*. The groove between *c* and *d* we regard as an indication of the main part of the inferior frontal sulcus; the sulci between *d* and *e*, *e* and *f*, we regard as parts of the middle (arcuate) sulcus.

Anterior to the cap in the Carmel cast is the sub-frontal notch (*i*) deeper and more oblique than in Fig. 241. Still farther forwards is the fronto-marginal notch. The convolutions and sulci seen on an anterior view of the frontal region we shall return to later. In the simplicity of its convolutionary pattern and in the form of its sulci and eminences the frontal region of the Carmel cast is very similar to that taken from the Galilee frontal.[2]

Parietal Region.

Before making a survey of this region in the Carmel cast it will be well to examine the more distinctly marked cast of the Negro child (Fig. 241). The main stem of the Sylvian fissure is represented here by a well-marked depression. The central fissure is represented by a slight groove (*c*, *f*). On each side of this groove are two knuckle-like elevations (*x*, *y*) which mark the knee of the central fissure. These elevations were noted by Professor

[1] See Keith, 1927, *Report on the Galilee Skull*, p. 95. [2] Loc. cit.

Le Gros Clark and his colleagues in the endocranial cast of the chimpanzee. Part of the post-central convolution can be recognized (*k*), but the parietal areas which are most conspicuous are the supra-marginal, angular, and post-parietal areas of the inferior parietal lobe (*l*, *m*, *n*). These areas are marked off from the superior parietal lobule by an irregular depression situated over the various parts of the intra-parietal fissural system.

In the Carmel cast (Fig. 240) we are at once struck by the prominence of the parietal eminences just mentioned, particularly those of the supramarginal and angular areas (*l*, *m*). The groove that indicates the central fissure is so slight that it would likely pass unnoticed by any one who did not know where to search for it. There are only suspicions of the general elevations, *x*, *y*. The convolutions of the inferior parietal lobule, supramarginal, angular, and post-parietal, are more distinctly differentiated from surrounding areas than in the Negro cast. Yet these areas are less extensive than in the Negro cast, and their pattern is less complicated. Of the superior parietal lobule no separate item can be distinguished; the depression which marks the site of the intra-parietal fissure is shallower and less continuous than in the Negro cast.

The two areas just described, the third gyrus of the frontal and the lower lobule of the parietal, are sites at which great cortical extensions have taken place during the evolution of the human brain. They are areas whose functional significance we do not yet know with precision, but we are justified in regarding them as necessary for the higher manifestations of man's mentality. Their development in the Carmel cast is certainly less than in the Negro cast. It is such a development as is met with in the brains of the modern aborigines of Australia. The prominence of the parietal areas may be due to a localized development of the cortex; but the prominence may be due to another factor. The prominent area of the parietal occurs on the central part of the lobe, the part which is covered by the central and first-formed part of the parietal bone. The central and oldest parts of the parietal are the most convex; the peripheral the least so. The convexity of the parietal areas of the brain lies under the central and most convex area of the parietal bone. Nevertheless, we hold that the prominences of the parietal cortical areas are in the main due to a functional differentiation of that cortex.

Temporal Lobe.

Usually the impressions which are produced by the irregularities of the temporal lobe are well preserved on endocranial casts. The area of the skull which contains the temporal lobe of the brain is covered in life by the temporal muscle. For some reason bone covered by muscle is highly sensitive to internal pressures, especially those which are localized. Unfortunately, on the left side of the skull of the Carmel child the temporal bone is missing. So, too, are the great wing of the sphenoid and the antero-inferior area of the parietal. Hence, on the left side the only temporal areas preserved are those of the hinder part which lie below the parietal lobe and in front of the occipital (Fig. 240).

On the right side the temporal bone is preserved. Hence, on the right side of the cast (Fig. 242) we have the impressions which are covered by the squama. This area is shown in the Negro cast (Fig. 241). We have seen that in the Neanthropic skull the squama extends forwards at the expense of the great wing of the sphenoid. Hence in the Negro cast the area is more extensive in an antero-posterior direction than in the Carmel cast,

but as regards their vertical extension both are approximately the same. In the Negro cast a deep depression separates the middle from the lower temporal gyrus. In the Carmel cast this sulcus is not represented, but it is probable that the notch on the lower border (Fig. 242 *x*) may correspond to it; the temporal notch appears in endocranial casts of the gorilla and chimpanzee. Along the upper border of the squama of the Carmel cast runs a deep depression which we regard as a ramus of the first temporal fissure.

On the Negro cast are indicated three elevated areas of the post-temporal region (Fig. 241 *p*, *q*, *r*). One lies immediately behind the area covered by the squama. It is part of the second temporal gyrus. This area is reproduced on the Carmel cast (Fig. 242 *r*), but its area is less extensive than in the modern example. Still farther back in the Negro cast are two other areas (Fig. 241 *p*), the infra-marginal area of the first temporal gyrus, and *q*, the infra-angular area of the second temporal gyrus. Both of these areas (Fig. 242 *p*, *q*) are reproduced in the Carmel cast, less clearly marked but almost as extensive as in the Negro cast. The three areas just mentioned, *p*, *q*, *r*, are sites which have undergone extension in the evolution of the human brain and may be connected with higher functions concerned with hearing and with sight. As in the frontal and parietal areas, the convolutionary pattern is simpler and rather less extensive than in our Negro cast.

Anterior View of the Frontal Areas.

As we have seen, the middle and lower parts of the frontal bone of the Carmel child had suffered grave damage. Hence the frontal region of the endocranial cast is imperfect, yet, as may be seen from Fig. 243, the anterior, or rostral, end of the superior frontal gyrus is prominent (Fig. 243 *a*) and separated from the orbital margin of the middle gyrus by the fronto-marginal notch (*b*). Along the anterior end of each superior gyrus runs a shallow furrow, parallel to the median plane. From the notch just mentioned begins a furrow representing the fronto-marginal, best marked on the right side. The sub-frontal notch is indicated on the left side (*d*) in front of the cap (*e*). Between the two notches, *b*, *d*, are two small projecting convolutions; they are situated on the orbital margin. In the Negro casts there is only one convolution between *b* and *d*, but it is apparently double in nature. In the Galilee cast both notches are well marked and the space between is occupied by two convolutions as in the Carmel cast. Indeed, there is a strong resemblance between the Galilee and Carmel casts in the region we are now describing. There is a high degree of asymmetry in the arrangement of the sulci and eminences of the two sides of the Carmel cast. On the right side a sickle-shaped depression lying above the convolutionary eminence marked *i* represents the arcuate or middle frontal convolution. On the left side this sulcus is represented by furrows placed at a higher level than on the right.

Occipital Aspect.

In Fig. 244 we reproduce a drawing of the occipital aspect of the endocranial cast of the Carmel child. The cast was placed as in Figs. 240 and 242 in the Frankfort plane. The asymmetry due to the earth compression, to which the skull had been subjected, is at once noticeable, the parietal eminence covering the inferior parietal lobule being higher on the left than on the right. These eminences are particularly well marked; the

sides of the cast are nearly parallel; the roof is 'well filled', there being only a very shallow depression along the site of the intra-parietal fissure. There are here none of the 'bun-shaped' features we meet with in the endocranial casts from Neanderthal skulls, such as that of the Gibraltar woman. The characters are those we meet with in casts taken from Neanthropic skulls, save in one respect. The lateral lobes of the cerebellum take a larger share in forming the lower lateral walls of the cast than is the case in casts taken from either Neanthropic or Neanderthal skulls. We have already noted the rounded backward projection of the cerebellar lobes. The prominence of the lateral lobes of the cerebellum, both in a lateral and in a posterior direction, is a character we meet with in the endocranial casts from chimpanzee and gorilla skulls. This must be counted a primitive or anthropoid feature in the Carmel cast.

The impressions of the occipital lobes, so far as they are covered by the squama of the occipital bone, are remarkably devoid of any indication of convolution or sulcus. Only on the left side (Fig. 244 *f*) is there a linear depression, horizontal in direction. Yet these occipital areas are extensive, particularly that of the left side. Nor are there any distinct indications of the fissures and sulci which separate the occipital from the parietal and temporal lobes. There is, just in front of the line of the lambdoid suture, and following the line of the suture, a groove on the cast, but this is really an impression made by the growing hinder margin of the parietal bone; the same impression, not so marked, is present on the Negro cast.

Venous Sinuses.

It is only under the posterior third of the sagittal suture that the longitudinal sinus makes a definite impression in the form of a longitudinal ridge bounded on each side by a shallow groove (Fig. 244 *d*). In the Negro cast the longitudinal sinus appears at the same point and in the same form. An endocranial cast of a gorilla has the same marking. Then, below the lambda, in the Carmel cast, there is a shallow groove separating the occipital lobes, but there is no definite evidence of the sinus until the region of the torcular is reached, when the sinus appears and turns wholly to the right side. On the left side the lateral sinus has left no *elevation* on the cast until the region of the asterion is reached. The markings for the lateral and longitudinal sinuses on the Negro cast reproduce exactly the arrangement seen in the Carmel cast.

Meningeal Arteries.

The branches of the middle meningeal artery are shown on the Negro cast (Fig. 241); the form of branching seen in the Carmel cast (Figs. 240, 242) is very similar. It will be noted that on the right side of the Carmel cast the middle meningeal gives off a large branch which passes backwards under the squamosal suture and is distributed to the posterior parietal region (Fig. 242 *v*). This branch is also present on the right side of the Negro cast. On the left side of both Negro and Carmel casts this division of the middle meningeal artery is represented by a small runnel.

Summary.

With the exception of the position of the lateral cerebellar lobe, there are no features of the brain of the Carmel child, so far as such can be ascertained from a study of endo-

cranial casts, that cannot be paralleled in the brain of modern people. There is a very close resemblance of the frontal markings of the Carmel cast to those of the Galilee cast. In volume the brain of the Carmel child fell very little below the mean for European children of a similar age. The convolutionary pattern is less complicated than is usual in modern brains. But those areas which our present beliefs lead us to associate with the higher functions of the brain are quite moderate in their development.

SKHŪL V (Pls. XXIV, XXV)

Endocranial Characters.

Only those who have attempted to remove hard limestone breccia from the interior of a human skull will realize the labour involved in obtaining an endocranial cast of the tall man, Skhūl V. The labour involved was increased by the fact that chisel and drill had to be applied through a restricted opening in the roof of the skull; the fact that the walls of the skull were comparatively thin and much more vulnerable than the breccia which filled them added to the difficulties that had to be surmounted. From the cleared-out cavity Mr. F. O. Barlow succeeded in obtaining a perfect cast of the cranial cavity which had been thus laboriously prepared. The cast throws much light on the outward form and cerebral equipment of this member of the Skhūl group.

We reproduce three drawings of the endocranial cast: in Fig. 246 are given details seen on the right lateral aspect; in Fig. 247 those seen on the left lateral aspect; and in Fig. 245 those apparent on the occipital aspect. All have been drawn with the endocranial cast orientated on the Frankfort plane. It is a fortunate circumstance that in human skulls the lowest level of the cerebrum, represented by the basal margin of the temporal lobe, is indicated approximately by the Frankfort plane. Hence measurements made on the cast are directly comparable to those made on the brain which was contained within the skull.

Before proceeding to give an account of the dimensions and character of the endocranial cast it is necessary to touch first on the fragment which is seen to rise from the vault of the cast (Fig. 246). It is due to a large part of the roof of the skull, including the greater part of the frontal and the anterior part of the parietal, having been forced upwards or disrupted by earth pressure. The left side of the skull, particularly the area which lies above the temporo-mandibular joint and ear, had been forced upwards, with the result that some part of the roof had to give way. The base of the skull rested on the left mandibular ramus which resisted the downward thrust of the rest of the skull, the thrust being caused by the weight of the cave earth which was superimposed on the skull. Thus it will be seen that the left hemisphere (Fig. 247) does not reach the Frankfort plane but is 9 mm. above it. In dealing with the skull of this man, we took the right side as the least disturbed side. If it had been possible, which it was not, to depress the left wall of the skull to its normal level, then the disrupted vault would have sunk in position. As things are, it was possible, when making the drawing of the parietal region of the skull (Fig. 165), to depress the hinder part of the fragment almost to its normal level and then, when drawing the frontal region, to depress the frontal end of the fragment until it made a normal contact. In the skull the highest point of the vault lay 117 mm. above the Frankfort plane; in the brain cast (Fig. 246) the highest point on the uplifted fragment is 119 mm.; could we depress the 'fragment' in the cast, as we did in

the skull, then the height of the crown above the Frankfort plane would be about 114 mm. That measurement we accept as representing the height of the cerebrum. When it is remembered that 114 mm. is the mean auricular height in English skulls, it will be realized that Skhūl V had a relatively high cerebrum. In La Chapelle man the cerebral height is 105 mm.

The right hemisphere, which measures 176 mm. from frontal to occipital pole, is longer than the left; the length of the left is 174 mm. As will be seen from Fig. 247, the right projects beyond the left at the frontal as well as at the occipital pole. We regard this discrepancy as a result of the pressure to which the left side of the skull has been subjected. The greatest width of the cast which lies low down, between the second convolutions of the temporal lobes, measures 138 mm. In measuring the skull we estimated the length of the cranial cavity to be 167 mm., and the intra-cranial width 134 mm. The width of the parietal lobes, measured on the cast above the level of the Sylvian fissure, is 133 mm.; of this amount the right hemisphere contributes 71 mm., the left 67, the smaller measurement on the left being due to compression. The greatest width of the frontal part of the cast measured at the coronal suture is 113 mm., while between the most projecting points of the frontal 'cap' the width is 106 mm. All these measurements fall well within the range which prevails in European males of moderate cranial capacity.

The width of the brain cast (138 mm.) represents 78·4 per cent. of the length (176 mm.); the proportion of width to length in the skull was 74·5 per cent. The difference is due to the projection of the supra-orbital torus; were these measurements to be reduced to modern proportions, then the skull would pass into the upper range of mesocephaly. The proportion which the height, measured in the mid-auricular vertical plane in the manner mentioned above, makes to the length of the right hemisphere is 64·7 per cent., a modern amount. Or if we compare the total height, measured on the cast from the position of the bregma to the position of the basion, 122 mm., with the maximum width, 138 mm., then the proportion of height is low, namely, 88·4 per cent. The brain was relatively wide and low.

When dealing with the skull of Skhūl V we made an estimate of the cranial capacity. The method we employed gave us an estimate of 1,518 c.c. We found the cast to displace 1,450 c.c. of water; we have thus to reduce our estimate by 4·5 per cent.—the brain of Skhūl V falling just below the mean volume for the men of modern Europe. It may be thought that the formula we have applied has given us over-estimates of the cranial capacity of the Skhūl men; we believe that if it had been possible to take endocranial casts of Skhūl IV and IX, their volume would have reached our estimates. We are certainly on safe grounds when we assume that, as far as volume of brain is concerned, the Skhūl men reached the average of modern Europeans.

Vascular Markings.

The distribution of the chief branches of the middle meningeal artery is shown in Figs. 246, 247. These are best demarcated on the left side where a large branch, not shown in our drawing, passes backwards near the upper border of the squama of the temporal to be distributed in the posterior parietal region. We can find no point in which the meningeal distribution differs from forms prevalent in modern people. As regards

the venous sinuses it will be noted that the longitudinal is marked at only one part of the sagittal suture, in the region of the obelion (Fig. 245). Pacchionian masses are plentiful, especially in the region of the bregma. Between the occipital poles the sinus lies in a wide shallow groove with flat bottom. The sinus, in the main, turns to end in the right lateral sinus, but seems to have been connected also with the smaller left lateral sinus.

Endocranium as a Whole.

Before proceeding to describe the convolutionary pattern of each lobe, it seems well to deal first with certain general features of the endocranium. As seen in profile the frontal lobe gives an impression of relative smallness. It will be recalled that the base of the skull, the basi-nasal diameter, of Skhūl V was remarkably short, 100 mm. against 110 in Skhūl IV and 109 in Skhūl IX. No doubt the shortening of the endocranium in its frontal region is due to the reduced base, and yet if we compare the actual size of that part of the frontal lobe which lies within the frontal bone, in front of the coronal suture (Fig. 246), with the dimensions observed in other endocrania, both of ancient as well as of modern skulls, we find no important point of difference. The frontal pole, as may be measured in Fig. 246, lies 53 mm. in advance of the mid-vertical point of the coronal suture; in the Galilee specimen this measurement is 47 mm.; in an English specimen 47 mm.; in an Australian 57 mm. Or if we take the extent to which the frontal pole projects in advance of the temporal pole, measured on such a drawing as is given in Fig. 246, we reach an equally negative result. In the endocranium of Skhūl V the frontal pole is 35 mm. in advance of the temporal pole (projection measured parallel to Frankfort plane); in a large English endocranium, 37 mm.; in Galilee, 45 mm.; in Gibraltar, 43 mm.; in an Australian, 46 mm. This projection is short in Skhūl V; but shortness in this projection seems to be a modern character.

Neither in width, nor in height, is that part of the endocranium which lies within the frontal bone unusually small. We have seen that the width of the frontal lobes, measured between the most laterally projecting points of the inferior convolutions, is 106 mm.; in the Galilee endocranium 105 mm.; in one Australian 88 mm.; in another 99 mm.; in Gibraltar 108 mm.; in Düsseldorf (Neanderthal) 110 mm. The frontal width may be described as moderate and the same description is applicable to the height of the frontal lobe. In the endocranium of Skhūl V the bregmatic point is situated, when the endocranium is orientated on the Frankfort plane, at a level which is 76 mm. above that of the lower or orbital border of the third frontal convolution. A comparison with measurements on other endocrania proves that in this point Skhūl V lies well within the range found in ancient and modern human skulls.

The second aspect of the endocranium of Skhūl V to strike the eye of the expert is the great fullness of that part of the brain which lies above the region of the ear, the hinder parts of the temporal convolutions, particularly of the second temporal. If the region of the temporal lobe just referred to is connected with hearing, words, or thought, then we may infer that Skhūl V was well endowed with the anatomical basis needed for the carrying on of such functions.

The third aspect that deserves mention is the large size of the convolutions and the simplicity of the convolutionary pattern. In this respect the Skhūl child has a resemblance to Skhūl V.

As in the child's endocranium, this one, too, gives the impression of a 'well-filled' skull. English anatomists speak of the skull of the Australian aborigines as being ill filled because the vault of the skull seems to be folded inwards and to be too large for the brain it contains. In Skhūl V the walls of the cranium are 'ironed out', flat on the crown, rounded and full on occiput and sides.

Indeed, in its outline, the endocranium of Skhūl V gives an impression of modernity, agreeing in its lines with those with which European anatomists are familiar. The occiput, as seen in profile, has premonitions of brachycephaly. The cerebellar lobes, in particular, are placed widely apart and project backwards to an unusual degree.

Convolutionary Pattern of Frontal Lobe.

The convolutions of the frontal lobe are simpler and more clearly marked on the left (Fig. 247) than on the right hemisphere. A slight groove on the cast in the fork of two branches of the middle meningeal artery (*e*, *e*) appears to indicate the site of the central fissure. This fissure is more extensively indicated on the right hemisphere (Fig. 246 *e*, *e*). There is no sign of the precentral sulcus, its course being covered by the cerebro-spinal pathway under the coronal suture and the cistern or pool in the region of the bregma.[1] Part of the original wall over the frontal lobe is lost, but the greater part of the inferior frontal sulcus is preserved, and the anterior part of the convolution (*a*, *a*). A notch on the orbital border of the convolution indicates the termination of the fronto-orbital fissure (*d*), while the fronto-marginal sulcus (*c*, *c*), the posterior end of which is continuous with the inferior frontal, is clearly indicated on both left and right hemispheres. On the left side the middle frontal sulcus (the arcuate of primatologists) is simple and is indicated by two limbs (*b*, *b*, *b*). On the upper part of the right frontal are depressions which represent the paramedian (*f*, *f*) and upper frontal sulci.

Fissure of Sylvius.

Before we describe the convolutionary patterns of the parietal and temporal lobes, it is necessary to consider that outstanding frontier on the lateral aspect of the brain represented by the stem and fissure of Sylvius. The stem, that part of the fissure which separates the orbital cap of the third frontal from the neighbouring part of the temporal lobe, is well preserved on the right hemisphere (Fig. 246, *dep.*); on the left the skull is damaged in this region. Naturally the stem is a wide and deep gap, for it is filled by that strong buttress of bone which we have described as the Sylvian falx (p. 234). There is no clear indication of either anterior, horizontal, or ascending limbs of the fissure of Sylvius, for the region in which they should appear is depressed by the rounded surface of the Sylvian falx which overlies this region (see Fig. 246, *dep*). The stem and the anterior Sylvian region are moulded to fit the mechanical conditions which prevail in primitive skulls in the region of the pterion. There is no evidence that the island of Reil was uncovered or that the opercula were not as fully developed as in modern brains. Indeed the contour in the Sylvian region of the endocranium suggests that the opercula (orbital, fronto-parietal, and temporal opercula) were large. The apparent deficiency in the region of the stem is due, as we have suggested, to a repression enforced on them by a massive bony falx sylvii.

[1] See Keith, 1927, p. 95.

We have not attempted to estimate the angle which the posterior limb of the fissure of Sylvius forms with the main horizontal axis of the brain; that angle will be modified according to the width of the base of the skull, quite independently of the proportion which one part of the brain bears to another. On the left side the posterior limb of the fissure of Sylvius occupies an abnormally high position, owing to the upward dislocation of the left side of the skull. On the right side (*fs*) it is very clearly demarcated. It is curved with its concavity directed upwards. The fissure is depressed where it passes under the lower end of the post-central convolution, this cortical area being highly developed. The fissure can be traced backwards until it lies below the angular gyrus (*m*). In Fig. 246 the posterior limb is drawn as if it were continued backwards into the post-parietal lobule (*n*), but it is probable that the hinder part should be assigned to the parallel fissure of the temporal lobe.

Parietal Lobe.

The interpretation of its surface markings is complicated by the displacement of part of the vault of the skull. On both sides the lower boundary of the lobe is clearly demarcated by the fissure of Sylvius; its anterior border is also indicated, but less clearly, by an oblique depression which appears to correspond to the central fissure (*e*, *e*), but its posterior limit, its separation from the occipital lobe, is not defined, there being an absence of convolutionary markings in the occipital area.

In the endocranium of the Skhūl child the three parts of the inferior parietal lobule stood out prominently above the level of the surrounding areas. On both sides of the endocranium of Skhūl V, these three parts, supramarginal (*l*), angular (*m*), post-parietal (*n*), are clearly defined, but are on a level with surrounding parts. Parts of the intra-parietal sulcus, the lower ascending (*h*) and horizontal (*i*), can be distinguished. We can detect no point which indicates that the cortical areas of the parietal lobe were less developed than in the brains of modern Europeans.

Temporal Lobe.

The full development of this lobe, particularly in its posterior or supra-auricular part, will be seen from our drawings. The first temporal (parallel) sulcus (Fig. 247 *t'*) is much broken up on the right, but less so on the left, not an indication of a primitive or ape-like state, but the opposite. As in modern European brains the second and third temporal sulci are broken up so irregularly that it is hard to build any system out of them. The part which lies within the temporal bone is marked by interrupted but deep sulci and a principal rounded convolution (*o*), the whole arrangement being easier to represent in a drawing than to describe in text. Especially noteworthy is the extent of the convolutionary elevations of the auricular region (*p*, *q*). It is probable that the sulci indicated by the letters *r*, *s* (Fig. 246) represent the sulci named 'Ascending II' and 'Ascending III' by Kappers and S. angularis and S. occipitalis anterior by Shellshear.

Occipital Aspect of the Brain.

In Fig. 245 we give a drawing of the occipital aspect of the endocranium of Skhūl V, the cast having been set on the Frankfort plane. Save for two slight oblique depressions, the parts of the occipital lobes which lie within the occipital bone are smooth and devoid

of all convolutionary pattern. The left occipital lobe is slightly more extensive in area than is the right, but it is the latter which projects the more backwards. That part of the occipital lobe which lies under the posterior or lambdoid margin of the parietal is grooved or depressed (Fig. 245 *dep*). Part of the longitudinal sinus (*ls*) in the region of the obelion is indicated by a short elevation; here, too, on the left there is a depression which probably indicates the site of the parieto-occipital fissure (Fig. 245 *po*). On the right side the angular (*r*) and anterior occipital fissure (*s*) are indicated. On the left the ramus occipitalis of the intra-parietal sulcus is suggested.

As will be seen from Fig. 245 the part of the occipital bone which contained the right lobe of the cerebellum was damaged, hence the deformed state of this lobe in the endocranium.

The width of the endocranium in its cerebellar region is unusually great. Measured between the lateral borders of the elevations which represent the sigmoid sinuses (Fig. 245 *ss*) the width is 121 mm. The left cerebellar lobe, measured in the Frankfort plane, projects 51 mm. behind the anterior border of the sigmoid sinus.

Summary.

We have given three drawings and a description of the characters presented by the endocranium of Skhūl V. The conclusion which our examination has forced upon us relates not to the dissimilarities but to the resemblances which this presents to casts taken from modern skulls, particularly of Europeans. Its volume, as determined from the cast itself, is 1,450 c.c., which is near to the mean cranial capacity of modern Europeans. In its general conformation and in the relation of one lobe to another, the Skhūl endocranium cannot be distinguished from certain modern forms. The parts of the brain which, on our present knowledge, are regarded as subserving the higher functions of the brain, and which represent the later evolutionary developments, are well marked in the cast. The outstanding character of the brain of this man, and the same is true of the Skhūl child, lies in the simplicity of the convolutionary pattern and in the amplitude of the individual convolutions. The cerebellar lobes were placed widely apart and projected backwards more prominently than is usual in modern skulls.



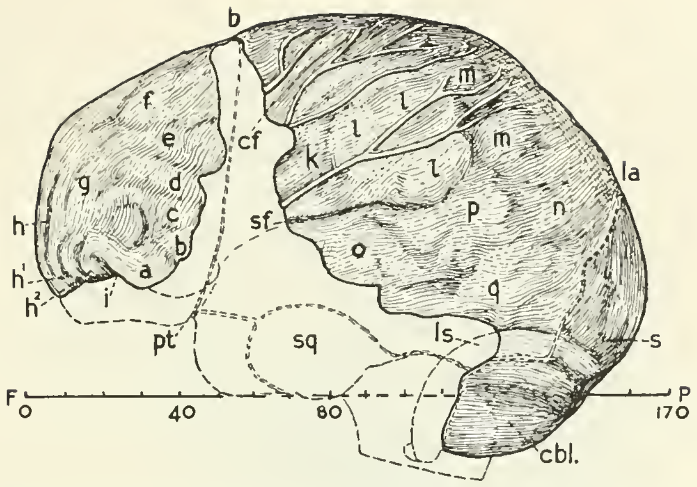


FIG. 240. LEFT HEMISPHERE OF THE ENDOCRANIAL CAST OF THE CARMEL CHILD (SKHŪL I) SEEN IN TRUE PROFILE AND ORIENTATED ON THE FRANKFORT PLANE (*F–P*) OF THE SKULL. The sutural outlines are indicated by double broken lines, those of the temporal being taken from the right side. The lateral sinus (*ls*) has also been completed from that of the right. The positions of the bregma (*b*), lambda (*la*), and pterion (*pt*) are indicated. The position of the coronal suture is indicated; *a*, *b*, *c*, convolutionary impressions of that part of the third frontal gyrus which forms the frontal cap; *d*, *e*, *f*, *g*, convolutionary impressions of the second or middle frontal gyrus, separated by depressions which represent the middle frontal (arcuate) fissure; *h*, h^1, fronto-marginal sulcus between the rostral part of the first gyrus, and the second; h^2, two prominent convolutions on the orbital margin belonging to the second frontal gyrus; *i*, subfrontal (fronto-orbital) notch; *cf*, position of the central fissure; *sf*, Sylvian fissure; *k*, part of the post-central convolution; *l*, *l*, *l*, parts of the supramarginal gyrus; *m*, parts of the angular gyrus; *n*, post-parietal gyrus; *o*, first temporal gyrus; *p*, submarginal area of first temporal; *q*, pre-occipital area of second temporal; *s*, left occipital lobe.

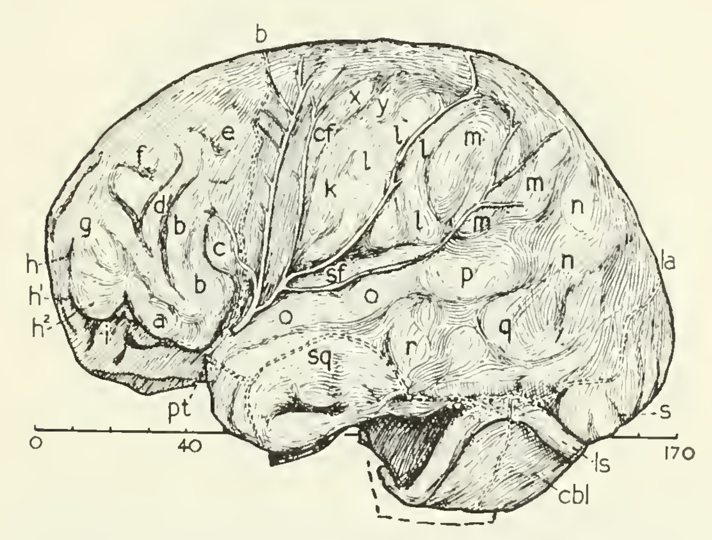


FIG. 241. CORRESPONDING DRAWING OF THE ENDOCRANIAL CAST TAKEN FROM THE SKULL OF THE NEGRO CHILD, THE SPECIMEN USED FOR COMPARISON IN THE CRANIAL CHAPTER. The sutural lines and ramifications of the middle meningeal artery are indicated as in Fig. 240. Similar indications are used for the convolutionary impressions with the following additions: *r*, post-squamous part of second temporal convolution; *x*, *y*, elevations on each side of the central fissure in the region of the genu.

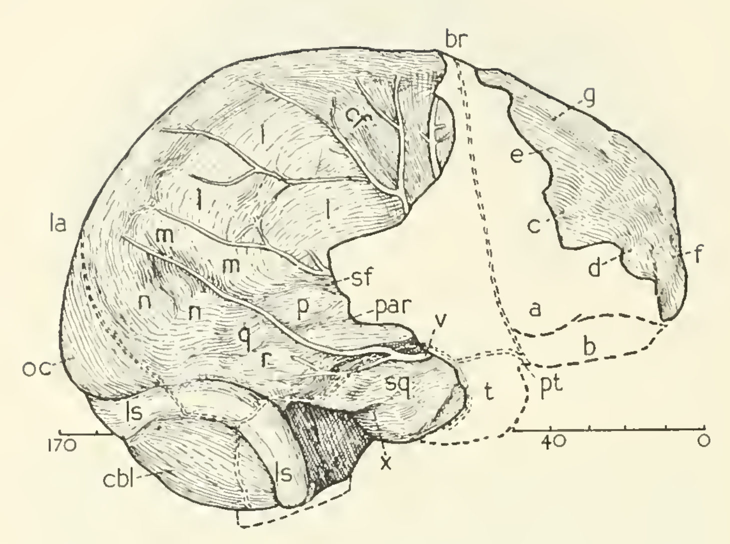


Fig. 242. Profile of the Right Hemisphere of the Skhūl I Endocranial Cast. It is orientated on the Frankfort plane. The sutural impressions are indicated by double interrupted lines. *br*, bregma; *la*, lambda; *pt*, pterion; *cf*, central fissure; *sf*, Sylvian fissure; *par*, parallel or first temporal fissure; *ls*, right lateral sinus; *oc*, right occipital lobe; *sq*, area covered by the squama of the temporal. *a*, situation of the cap of the third frontal gyrus; *b*, orbital area; *c*, part of the middle (arcuate) sulcus; *d*, *a*, ramus of the lower frontal sulcus; *e*, upper part of second frontal gyrus; *f*, fronto-marginal sulcus; *g*, upper part of first frontal sulcus; *l*, *l*, *l*, supra-marginal area; *m*, *m*, angular area; *n*, *n*, post-parietal; *p*, infra-marginal elevation of first temporal; *q*, *r*, infra-angular areas of second temporal; *t*, part of temporal lobe covered by great wing of sphenoid; *v*, lower (squamous) branch of middle meningeal; *x*, infra-temporal notch.

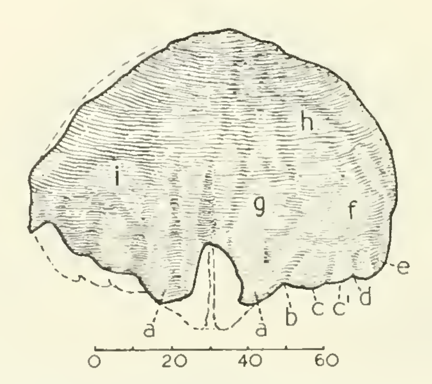


Fig. 243. Anterior Aspect of that Part of the Endocranial Cast of the Carmel Child which is Contained within the Frontal Bone. Drawn with cast set on the Frankfort plane. *a*, rostrum of the first frontal convolution; *b*, fronto-marginal notch and beginning of fronto-marginal sulcus; *c*, *c'*, two knuckle-like eminences on the frontal margin of second frontal gyrus; *d*, subfrontal notch; *e*, cap of inferior frontal gyrus; *f*, inferior frontal gyrus; *g*, superior frontal gyrus; *h*, convolutionary eminence of the middle gyrus, between two furrows which appear to represent the middle or arcuate sulcus; *i*, part of the middle gyrus of the right lobe.

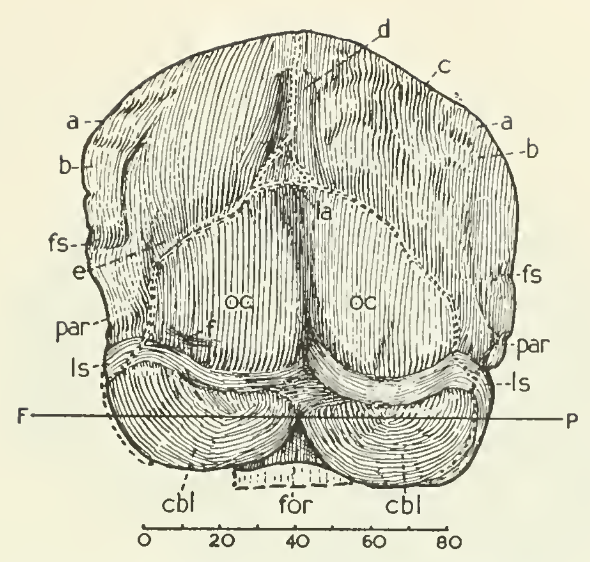


FIG. 244. A DRAWING OF THE OCCIPITAL ASPECT OF THE ENDOCRANIAL CAST OF THE CARMEL CHILD. The cast is represented on the Frankfort plane (*F–P*). The sutural lines are indicated by double lines. *a*, *b*, areas of the inferior parietal lobule; *c*, position of intraparietal fissure (pars horizontalis); *d*, impression of the posterior part of the longitudinal sinus; *e*, pre-lambdoid impression; *f*, sulcus on left occipital lobe; *for*, foramen magnum; *fs*, hinder end of Sylvian fissure; *par*, hinder end of parallel fissure; *la*, position of lambda; *ls*, lateral sinus; *occ*, occipital lobe.

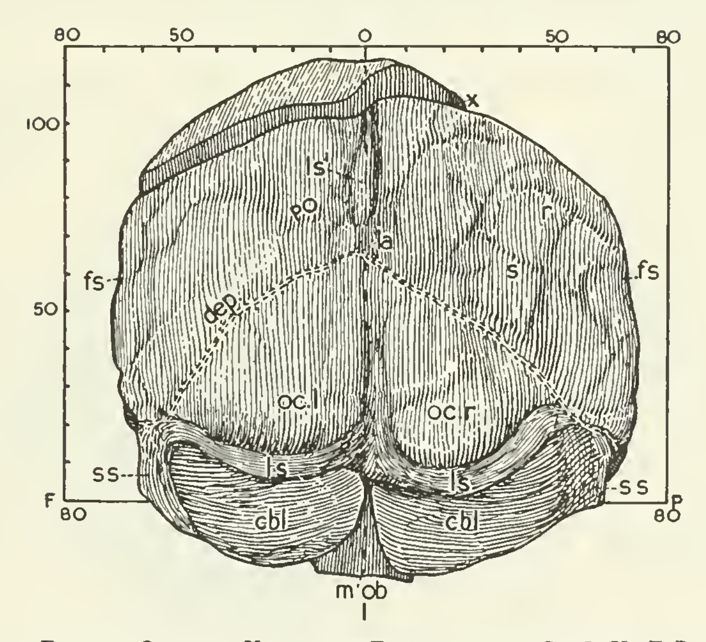


FIG. 245. OCCIPITAL VIEW OF THE ENDOCRANIUM OF SKHŪL V. *F–P*, Frankfort plane, *O–O*, mid-sagittal plane; *x*, vault fragment; *fs*, termination of Sylvian fissure; *ls*[1], obelial part of longitudinal sinus; *ls*, right and left lateral sinus; *la*, lambda; *dep*, depressed groove corresponding to posterior margin of parietal bone; *oc.r*, *oc.l*, right and left occipital poles; *po*, site of parieto-occipital fissure; *r*, angular sulcus; *s*, anterior occipital sulcus; *ss*, sigmoid sinus. Further description in text.

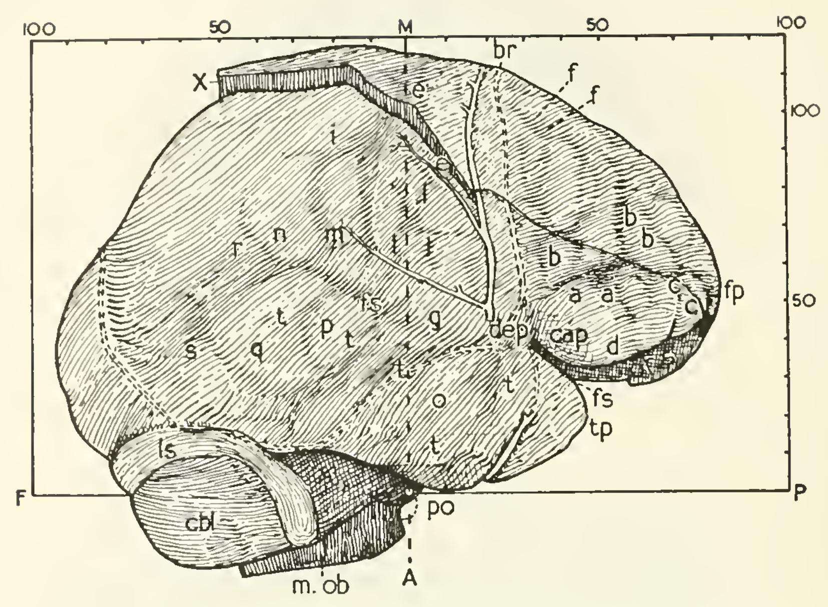


Fig. 246. A Drawing of the Right Lateral Aspect of the Endocranial Cast of Skhūl V. It is orientated on the Frankfort plane (*F–P*). The porion (*po*) and vertical mid-auricular plane (*M–A*) are also indicated. *x*, disrupted fragment of vault. The situations of the coronal, lambdoid, and squamous sutures are indicated by broken lines. *m.ob*, medulla oblongata; *ls*, lateral sinus; *cbl*, cerebellum; *br*, bregma; *la*, lambda; *fp*, frontal pole. For further descriptions see text.

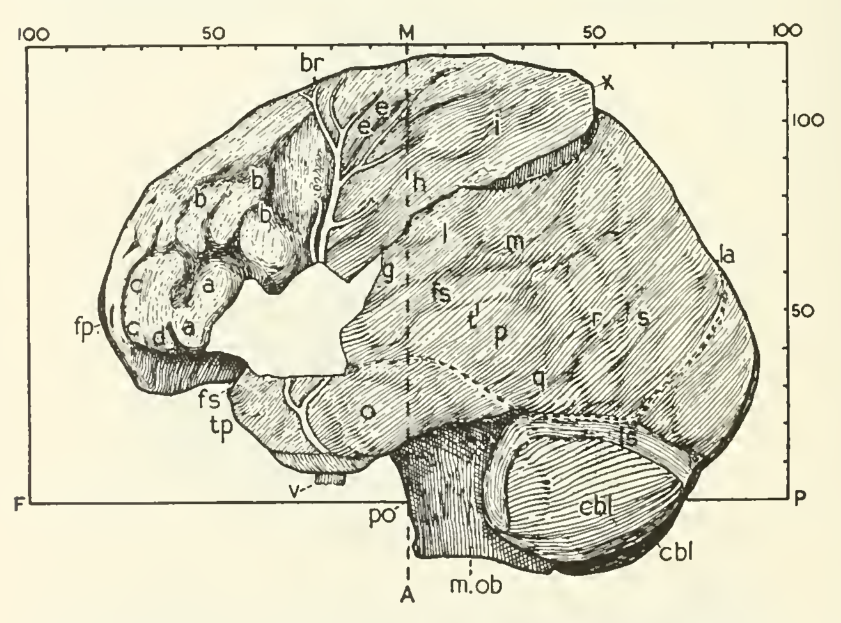


Fig. 247. Left Lateral Aspect of the Endocranial Cast of Skhūl V. The Frankfort plane, which is indicated (*F–P*) is taken from the right side (Fig. 246). The dislocation upwards of the left half of the skull and endocranium is explained in the text. *x*, vault fragment, displaced upwards. Other indications as in Fig. 246. In the region of the pterion, part of the cranial wall is missing. *cap*, orbital cap of lower frontal convolution; *tp*, temporal pole; *fp*, frontal pole; *fs*, fissure of Sylvius; *dep*, depression over stem of fissure of Sylvius.

CHAPTER XXII

AN ANALYSIS OF THE STRUCTURAL CHARACTERS OF THE MOUNT CARMEL PEOPLE

WITH A NOTE ON THEIR DISEASES, INJURIES, AND LONGEVITY

MARCELLIN BOULE, in his monograph on *L'Homme fossile de la Chapelle-aux-Saints* (1911), has laid a foundation upon which other workers must build. He gives (p. 226) a list of characters which distinguish the Neanderthal species of man. We shall enumerate these characters in one column—altering his arrangement only in minor points; side by side with it we shall set a second column in which the corresponding characters of the Mount Carmel people are listed and agreements as well as differences noted. Then, in a third column, we shall give the corresponding characters of early Neanthropic peoples, selecting the Cromagnon described by Dr. René Verneau (1906) as a basis for our statements:

Analysis of the diagnostic characters of the type or species represented by:

	NEANDERTHAL MAN	MOUNT CARMEL MAN	CROMAGNON MAN
1.	Stature, short but stocky.	Men tall, women short or of medium stature.	Men tall, women of medium stature or small.
2.	Head massive with the facial parts large relatively to the brain-containing part.	Head massive, but face not excessively developed.	Head massive, but face not excessively developed.
3.	Skull dolichocephalic or mesaticephalic.	Most are strongly dolichocephalic but one—Tabūn woman—has an index of 77.	Most are strongly dolichocephalic.
4.	The vault is very low (platycephalic).	Vault of medium, or even above medium height.	Vault high.
5.	Eyebrow ridges assume form of continuous torus.	Torus, but with a tendency to separate into medial and lateral parts.	Separation into medial and lateral parts is complete.
6.	Forehead very receding.	Forehead moderately full.	Moderately or fully developed.
7.	Occiput 'en bourrelet', compressed vertically; does not project behind attachment of neck.	Not compressed vertically. Projects slightly beyond attachment of neck.	Compressed laterally. Projects well behind attachment of neck.
8.	Face—particularly the upper face—very long.	Face of moderate—or above moderate—length.	Face of moderate length.
9.	Face prognathous.	Face usually orthognathous.	Face orthognathous.
10.	Malar bone has the flat form seen in anthropoid apes.	Malar is flat and anthropoid-like, but with a decided tendency in some individuals towards a Neanthropic form.	Malar is Neanthropic.
11.	Superior maxillae are devoid of canine fossae and are snout-like in form.	Superior maxillae, although devoid of fossae, are flattened in front but are usually not snouted.	Neanthropic.
12.	Orbits are large and rounded in form.	Orbits wide but not high.	Orbits wide but not high.

	NEANDERTHAL MAN	MOUNT CARMEL MAN	CROMAGNON MAN
13.	Nose very large, projecting and wide, its lateral margins not demarcated from face.	Nose variable in projection and width. Laterally it is partially demarcated.	Nose variable in projection, usually narrow; laterally sharply demarcated.
14.	Subnasal part of face is deep and wide.	Subnasal area wide, but not deep.	Subnasal area moderate in width and depth.
15.	Mandible robust.	Variable—some robust, others if large yet not robust, some small, but stoutly built.	Moderate in development both in size and in strength.
16.	Chin absent or rudimentary.	Chin absent or of moderate development.	Chin moderate or well developed.
17.	Ascending mandibular ramus very wide.	Width varies—in some very wide, others of moderate width.	Width varies; some very wide.
18.	Mandible, in the region of the angle, truncated or flattened.	Angle moderately developed.	Angle moderately or well developed.
19.	Teeth are big.	Teeth are moderate in size or large.	Teeth moderate in size.
20.	Molars retain certain primitive characters.	Molars retain certain primitive characters.	Molars are Neanthropic in characterization.
21.	Spinal column and its vertebrae present pithecoid characters.	Spine and vertebrae possess certain Neanderthaloid features; others are Neanthropic.	Spine and vertebrae are Neanthropic.
22.	Adaptation to the upright posture and to bipedal progression less perfect than in Neanthropic man.	Adaptation to bipedal progression apparently as perfect as in modern man; cervical curvature probably less developed than in Neanthropic man.	As in Neanthropic man.
23.	Lower limbs short.	Lower limbs long.	Lower limbs long.
24.	Mean cranial capacity about 1,400 c.c.	Capacity in three adult males ranges from 1,518 c.c. to 1,587 c.c.; one woman (Tabūn) 1,271 c.c.; one woman (Skhūl) about 1,300 or 1,350 c.c.	Capacity large.
25.	In form the brain shows primitive or simian features, particularly in the small size of frontal lobes and in convolutionary pattern.	Neither in size nor in form of lobes is there a decided difference from brain of Neanthropic man. Convolutionary pattern—so far as our evidence goes—was simple.	Lobes large and well convoluted.

When we analyse the twenty-five characters tabulated above we find only three in which the Mount Carmel people answer to M. Boule's definition—in the frontal torus, in the form of malar, and in the pattern of molar teeth. In eight they agree with the Cromagnon type. In twelve they are intermediate; three characters are common in all three—namely, dolichocephaly, a wide ascending mandibular ramus and a moderate or large cranial capacity. If we base our conclusions solely on these diagnostic characters, then we must regard the Mount Carmel as an intermediate people in which Cromagnon (Neanthropic) characters predominate over those which are Neanderthal (Palaeoanthropic).

M. Boule sums up his impression of the Neanderthal type—as compared with the Cromagnon type—in the following paragraph (p. 227):

'What a contrast with the men of the succeeding geological period, the men of the Cromagnon type, with their elegant body, splendid head, and a forehead high and wide; who have left in the caves they inhabited so many evidences of their skilled handiwork, of their fertility of invention, and of their

preoccupation with matters artistic and religious, of their faculty for abstract thought; the first to merit the glorious title of "*Homo sapiens*".'

Seeing how largely the Mount Carmel people share in the characteristics of Cromagnon man, we may justly claim part of Boule's eulogy for the people described in this work.

Further Analysis.

Besides the list of characters used in the differential diagnosis of the Neanderthal species, Boule gives a much longer table of the structural features which bear upon the relationship of Neanderthal man to anthropoid apes, and to living races of mankind. We shall now pass in review the characters enumerated in this longer list (p. 222)—excepting, of course, those we have just considered—and note, as we go, the form which these characters assume in the Mount Carmel people.

A. Cranial and Facial Characters.

1. *Basi-Cranial Angle.* Of all the Neanderthal skulls known to us, there is only one in which the base is approximately complete and in which the basi-cranial angle can be accurately determined. This is the original Gibraltar skull. In 1909 Professor G. L. Sera drew attention to the small degree of flexure or bending in the base of the skull. He measured the angle and found it to be 140°—only slightly less than in anthropoid skulls.

Not one of the Mount Carmel skulls has a base sufficiently intact to permit exact measurement of the basi-cranial angle. There is evidence, however, which leads us to infer that the flexure, if not so acute as in modern races, was not markedly different.

2. *Plane of the Foramen Magnum.* Closely associated with the size of the basi-cranial angle is the angle which the plane of the foramen magnum makes with the Frankfort plane. The more the base is flexed, the more does the foramen tend to look forwards as well as downwards; the less it is flexed, the more it tends to look backwards as well as downwards. The only specimen from Mount Carmel in which the direction of the foramen magnum could be determined was Skhūl V. In it the foramen looked downwards and slightly forwards, its plane making an angle of $-11{\cdot}5°$ with the Frankfort plane; in the Australian skull used for comparison, this angle measured $-14°$. In the Gibraltar and La Chapelle skulls the direction is downwards and slightly backwards, the angle in the first being $+3{\cdot}5°$, in the second $+7°$. In this feature Skhūl V is Neanthropic, and we suspect that such had also been the case in all the Mount Carmel skulls.

3. *Sutures* were simple in the La Chapelle skull, and this is the case in the Mount Carmel skulls—so far as these remain open. Yet it is a simplicity of about the same degree as that met with in the skulls of Australian aborigines. As usual the lambdoid is the most complicated, especially in the child's skull. In none did we find the fern-like complexity shown by the lambdoid suture of the Gibraltar skull.

4. The *squamous* (parieto-temporal) *suture* of the Mount Carmel skulls is intermediate to the Neanderthal and Cromagnon crania—both in curvature and height. The suture is higher and more curved than in Neanderthal skulls but less so than in Neanthropic crania. In Neanthropic crania the squama of the temporal is more extensive, extending farther up the side of the skull and farther forwards into the floor of the middle cranial

fossa. The arching of the squamous suture is related to the bending of the base of the skull; the more the base is bent the higher and sharper is the arch of the squamous suture.

5. Closely related to the character just mentioned is the degree to which the *great wing of the sphenoid*—and also the orbital plate of the malar—are developed on the floor of the temporal fossa. In Neanderthal skulls the great wing and the orbital plate of the malar tend to be wide; in Neanthropic skulls they tend to be narrow. The Mount Carmel people retain the Neanderthal width of the sphenoid.

6. The margin of the *zygomatic arch* descends well below the Frankfort plane in Neanderthal and anthropoid skulls. In Neanthropic skulls the upper margin is level with or above this plane. The Neanderthal form appears to have prevailed in the Mount Carmel people, but in all our specimens there was injury to or distortion of the zygomatic and orbital regions.

7. The *mastoid process* is peculiar in shape and small in size in Neanderthal skulls. In Neanthropic skulls, especially of European males, this process is pyramidal in shape, massive in size, its apex usually descending to, or below, the level of the occipital condyles. In the Mount Carmel people the mastoid may be Neanderthal in size and shape, may be intermediate in size, or large and pyramidal. The large type of process is the farthest removed from the anthropoid form.

8. The *nuchal area*, provided by the occipital and by the mastoid part of the temporal for the attachment of the neck, is very extensive in the Skhūl men, indicating thick and strong necks. The muscular impressions of the nuchal area resemble those seen in Neanderthal more than those of Neanthropic skulls. The *torus occipitalis* is also intermediate in its characters; there may be a more or less defined external occipital protuberance in Carmel crania. In representative Neanderthal skulls the nuchal area is flattened and the region of the inion rises high above the Frankfort plane; in Neanthropic skulls the nuchal area is usually convex and the region of the inion lies on or below the Frankfort plane. In Mount Carmel skulls the nuchal area is convex and the region of the inion usually lies well above the Frankfort plane.

9. In Neanderthal skulls the *external auditory meatus* tends towards an oval form with the longest diameter lying in a horizontal plane. The tympanic plate, which forms the floor of the meatus, is also horizontal. In Neanthropic skulls the long axis of the meatus is vertical, the meatus having the appearance of having been compressed from front to back, the Neanderthal from above downwards. Both forms are found amongst the Mount Carmel people, but the prevailing characters are Neanthropic.

10. The *vaginal ridge* of the *tympanic plate* is low and divides the plate into anterior and posterior parts in Neanderthal skulls. In the Mount Carmel skulls the posterior part of the plate is greatly reduced, although not so much as in Neanthropic skulls.

11. The shape of the auditory meatus is determined by the form given to the *temporo-mandibular joint*. If the posterior part of the joint is excavated to form a deep glenoid cavity and its anterior part remains as an articular eminence—as in Neanthropic skulls—then the meatus assumes the appearance of compression from before backwards. If the glenoid cavity is deep then the tympanic plate, instead of being almost horizontal, becomes almost vertical, to form the posterior wall of the glenoid cavity. In all of the Mount Carmel skulls—including that of the Tabūn woman—the temporo-mandibular joint has

assumed Neanthropic characters to a greater or lesser degree—lesser in the Tabūn woman and greater in Skhūl IV. Indeed the temporo-mandibular region of Skhūl IV may be described as ultra-modern.

12. In Neanderthal skulls the *spina glenoidalis*—which forms the deepest and most medial part of the joint—is well developed, and when a skull is arranged on the Frankfort plane its spina glenoidalis descends well below that plane. Usually in Neanthropic skulls the spina glenoidalis is less developed; in the Tabūn woman the spina glenoidalis reaches a Neanderthal stage of development; in the Skhūl crania it is Neanthropic in its development.

13. The *post-glenoid spine* is of moderate development in the Mount Carmel people, but is larger than is usual in modern skulls.

14. The *pterygoid processes* of the sphenoid were observed by Boule to pass forwards as well as downwards in the La Chapelle skull—as in anthropoid apes. These processes are very imperfectly preserved in the Mount Carmel skulls but they seem to have the same angle of inclination to the Frankfort plane as in Neanthropic skulls.

15. In Neanderthal skulls the *zygomatic arch* and *malar* merge into the maxillary part of the face, whereas in Neanthropic skulls the malar part of the arch is sharply differentiated from the maxillary part of the face. The condition found in the Mount Carmel skulls varies in degrees of sharpness, but in all the condition may be said to be intermediate to the Neanderthal and Neanthropic forms.

16. The area of the *palate* is very great in both Neanderthal and Mount Carmel skulls. Both differ from the form of palate found in anthropoid apes and also in primitive Neanthropic races by the palatal width greatly exceeding the palatal length, but both agree with anthropoid apes and differ from Neanthropic man in the relatively great width of the palate in its anterior or canine region.

17. The *palato-cerebral ratio*[1] in the Mount Carmel people is the same as in Neanderthal man. In the La Chapelle skull the palatal or palato-dental area is 39 cm.^{2}, the cranial capacity 1,620 c.c.—the ratio leaving 1 cm.^{2} of palatal area to 41·5 c.c. of capacity. In Skhūl IV the corresponding data are 35·4 cm.^{2}, 1,554 c.c., = 1 : 43·9; in Skhūl V, 36·3 cm.^{2}, 1,450 c.c., = 1 : 40. In the Tabūn woman the data are 32·9 cm.^{2}, 1,271 c.c., = 1 : 38·6. These figures for the Tabūn woman are almost the same as those for the Gibraltar (Neanderthal) woman—namely, 31·6 cm.^{2}, 1,270 c.c., = 1 : 40. In modern man the palato-cerebral ratio may be as low as 40 or as high as 60, but the low ratio in modern man is due to a small cranial capacity whereas that of Neanderthal and Mount Carmel peoples is due to the largeness of the palate.

18. One of the most surprising features of the Mount Carmel people is their *orthognathism*, the face being bent backwards under the base of the skull to a greater or less degree. Boule found prognathism in La Chapelle man; on the other hand, the face of the Gibraltar skull is orthognathous, the naso-alveolar line forming an angle of 89° with the Frankfort plane. In Skhūl IV this angle measures 97°; in Skhūl V there is a marked degree of prognathism, the facial angle being 73·5°.

19. There was only a slight degree of *subnasal prognathism* in La Chapelle man, none in the Gibraltar woman. The same statement holds true of the Mount Carmel people; it is most apparent in Skhūl V, where it is very considerable. Subnasal prognathism is

[1] See Keith, 1925, vol. ii, p. 659.

a character of anthropoid apes and also of some of the more primitive races of mankind (African and Australian native races).

20. In none of the Mount Carmel skulls could the axis of the *orbits* be determined accurately, but the evidence available points to the orbital axis holding the same relationship to the Frankfort plane as in modern skulls.

21. Of all the Neanderthal skulls known to us there are only two in which the *roof* of the *nose*—including the nasal bones—is intact, namely, the Gibraltar skull and Krapina C. In both of these the bridge or dorsum of the nose has the same peculiar form—gently concave from glabella to the upper margin of the nasal aperture and roundly convex from side to side—a miniature riding saddle with pommel above and croup below. At the nasion the nose fades into the forehead; at its sides it fades into the maxillary region of the face—as in anthropoid apes. None of our Mount Carmel people had this saddle form of nose; in all of them this is separated from the glabellar region by a 'notch' which is slight in the Tabūn woman, Skhūl IX, and the Galilee man, but is deep in two of the Skhūl people (II, V)—deep and transverse as in Australoid skulls. The sides of the nose are demarcated by a vertical groove, more or less distinct, appearing between the ascending nasal process of the maxilla and the body of that bone. In the Mount Carmel people we have stages in the differentiation of the nose of Neanthropic man. The lateral differentiation is not present in the La Chapelle skull. Boule describes the root of the nose as being separated from the glabellar region by a deep notch—'encoche nasale profonde'. Further, Boule draws attention to the great forward development of the nasal process of the maxilla in the Chapelle skull—giving the dorsum of the nose an advanced position on the face. In brief, were the nose of La Chapelle man to undergo the demarcative changes just described it would assume a Roman-like prominence. A prominent nose is an ultra-human character. So, too, in the Gibraltar skull the nasal processes of the maxilla are very extensive. In Skhūl IV these processes—partially demarcated—are as prominent as in the La Chapelle skull. In the others, particularly in Skhūl V, they are of moderate size. The nose was variable in its prominence among the Mount Carmel people; as in all Caucasian races, it was greatly developed in some, much less so in others. In these nasal features the Mount Carmel people bridge the gap between the Neanderthal and Cromagnon types.

22. There is another feature of the nose of the Mount Carmel people which is of an intermediate nature. This is in the conformation in the *lower margin* or *sill* of the nasal or pyriform aperture. Recently we have succeeded in removing the breccia which filled the nasal cavity of the Gibraltar skull, and revealed that within the outer threshold or margin there lies a second or inner threshold; the two being separated by a narrow groove or space. The outer sill is raised, sharp, and continuous from spine to lateral wall; the inner margin is also raised and continuous. The margin of the La Chapelle skull has a similar demarcation. It is scarcely necessary to state that the primary form of nasal sill is that seen in the skulls of anthropoid apes—where the floor of the nasal cavity passes forwards to merge with the premaxillary surface without demarcation. The medial and lateral elements which go to form the bony sill are separated by a wide groove. This primitive form persists in all modern races in which there is subnasal-prognathism. It is only in the more civilized races of modern man that the lateral and medial elements unite to form a raised, sharp, nasal sill. In modern races this sill is being evolved now;

it was evolved long ago in the Neanderthal people of Western Europe. In the Mount Carmel people we find it in all stages of evolution; it was apparently a sharp ridge in Skhūl IX; in all the others it is in varying stages, but in none does it retain the open (simian) gutter form. Amongst the Krapina people the open gutter was present to a greater or less extent as it was in Cromagnon man. We have gone into this feature in some detail because (1) the Mount Carmel people show so many stages in the evolution of the sill and (2) because it seems to illustrate the independent acquisition of a character by races which must, in a genetic sense, stand widely apart.

23. The *nasal spine* is a human character. It is well developed in both Gibraltar and La Chapelle skulls where it is triangular in shape, flattened on its upper surface, with the apex of the triangle projecting forwards. In none of the Mount Carmel skulls was this structure intact; it was certainly of moderate size; the parts which are present do not differ in form from those that are to be observed in Neanthropic skulls.

24. The flattened form of the *malar* or cheek bone—an anthropoid feature—has been already mentioned in our list of diagnostic characters. But one aspect of it deserves emphasis. The diagnostic feature of the Neanthropic cheek lies in its separation from the maxillary part of the face. This depends on two changes: (1) the increase in size and lateral prominence of the part of the malar to which the masseter muscle is attached; (2) the sinking down of the malar—a process we have named zygoproptosis. We see in the faces of the Mount Carmel people early stages in the differentiation of the Neanthropic malar from one which had been Neanderthal in type.

B. Characters of the Mandible.

25. Certain features of the *mandible* have been enumerated in the list of diagnostic characters. In Tabūn II the mandible rivals in size and strength that of Mauer (Heidelberg) or of La Chapelle; that of Skhūl II (a woman) is thick but very shallow or narrow in its body; save for its thickness it is no larger than in mature women of living races.

26. There are certain features of the *chin* we must touch on again. The Tabūn woman was almost as chinless as the Heidelberg man; the Tabūn man had a chin which, if small in relationship to the size of his mandible, is yet a well-defined knobby eminence. In Skhūl V the chin is only a slight degree more differentiated than in the Tabūn man, while in Skhūl IV and in Skhūl II the chin reaches as high a stage of development as occurs in the aborigines of Australia. In chin development the Carmel mandibles stand between the lower forms met with among the Neanderthalians and the higher or modern form found in the Cromagnon people.

27. In the modelling of the *lingual aspect* of the *symphysis* we meet with a similar series of transitional forms. There are those which have a deep fossa or pit in which the genio-glossal muscles take their origin. There are others in which this pit is almost filled up, and a stage reached in which the lingual muscles take their origin as in the more primitive of living races. The degree to which the genial pit or fossa is filled up by bone varies even in Neanderthal mandibles, but the stages seen in the Mount Carmel mandibles are the nearer to the Neanthropic condition. What we have said of the impressions for the lingual muscles may be applied to those for the digastric muscles.

28. The varying width of the *ascending ramus*, and the degree to which an 'angle' has been developed in the mandible of the Mount Carmel people has been already

considered (pp. 217–9). In Neanderthal man Boule has noted: 'Apophyses coronoïdes basses, échancrure sigmoïde peu profonde.' This description is certainly true of the Heidelberg mandible but is not applicable to those of the Mount Carmel people. As already mentioned, the mandible of Tabūn II is as big as the Heidelberg mandible. When their profiles are superimposed, so that condyle coincides with condyle, and incisor teeth with incisor teeth, it is seen that the anterior border of the coronoid of the Tabūn mandible lies somewhat in front of that of the Heidelberg mandible, and that the tip of the coronoid rises somewhat higher and that the sigmoid of the Tabūn specimen is somewhat deeper. No doubt the size and shape of the coronoid varies in the mandibles of the Neanderthal people. It varied amongst the Krapina people and it varied amongst the Mount Carmel people, but a coronoid which rises much above the level of the condylar process (with skull arranged on the Frankfort plane) does not occur in any of the three groups. In all of these groups the coronoid is strengthened by certain ridges of bone.

29. Boule describes the *condylar process* of the Neanderthal mandible as 'trés volumineux'. Amongst the Mount Carmel people this process may be robust as in Tabūn II, and also in Tabūn I, or it may be quite modern in its conformation and size—as in Skhūl V. The stem or neck of the condylar process is usually long and strong.

30. The *gonial angle* varies from 104° to 118° in the Mount Carmel people—a range similar to that found in the Neanderthal people of Europe and also the Krapina people. These variations also fall within the range found in the mandibles of modern races.

C. Dentition.

31. The *teeth* of the Mount Carmel people have a closer resemblance to those of Krapina than to any other human fossil teeth known to us. This holds true of all forms of teeth—incisors, canines, premolars and molars—both milk and permanent. This statement, however, although applicable to all members of the Tabūn type, does not apply to the incisor and canine teeth of certain of the Skhūl type—particularly Skhūl IV. A full analysis of dental characters is given in Chapter XIII.

32. The *dimensions* of the Mount Carmel *teeth* are moderate—being less than in the Krapina people, the Neanderthalians of western Europe, and in the native people of Australia. They differ from most teeth of modern peoples by having a great labio-lingual diameter of the crown, and in this they agree with Neanderthalians, and there is in them, as in the Neanderthalians, a tendency to a cusp-like development on the lingual aspect of the incisor and canine teeth.

33. The Mount Carmel *molars* differ from those of modern peoples by usually having five cusps, an anterior fovea, and a posterior fovea.

34. *Taurodontism*, which affects nearly half of the Krapina dentitions and a proportion of the Neanderthals of western Europe, is absent amongst the Mount Carmel people. Yet there is a tendency towards this condition manifested by a shortening and approximation of the roots of the molar teeth.

D. Characters of the Trunk.

35. Boule counts certain features of the *spinal column* to be characteristic of the Neanderthal species. 'Colonne vertébrale courte et trapue' is his record. The Mount Carmel

people (Skhūl IV, V, and Tabūn I) certainly share these characters; the bodies of their vertebrae—in all regions of the spine—are shallower than in modern peoples.

36. The bodies of the *lumbar vertebrae* are relatively narrower than in modern people.

37. The *spinous processes* are longer, more horizontal, but not so robustly formed as those of modern peoples. This is also a Neanderthal character.

38. The *spinous processes* of the *cervical vertebrae* are not so long as in the La Chapelle spine, nor are they so strong; but they are longer than in modern races and their points or tips are undivided.

39. The *atlas* and *axis* are of remarkably small size—especially when the great strength of the head they supported is taken into consideration.

40. The *cervical* and *lumbar curves* were developed to only a slight extent amongst the Neanderthal people. Such evidence as we have indicates that, so far as the cervical curvature is concerned, this statement holds true of the Mount Carmel people—but not as regards the lumbar curvature. Our evidence points to this curvature being developed at least to the extent found in modern native races.

41. 'The sacrum was but slightly curved; its lateral masses were not wide and it was deeply sunk between the iliac wings of the os coxae.' We have only fragments of the *sacra* of the Mount Carmel people; they were apparently relatively straight and narrow, but we have no evidence that they were 'très enforcé entre les ailes iliaques'. Indeed this is unlikely, for the iliac wings are remarkably low or shallow.

42. The *ribs* of Neanderthal man were thick as regards their medio-lateral diameters but narrow between their upper and lower borders, and they were curved as they would be in a thorax which is barrel-shaped—an anthropoid feature. These features we find among the Mount Carmel people, particularly in Tabūn I; they were also noted in Skhūl V; in Skhūl IV the ribs tend to assume, in their lateral and ventral segments, the flattened blade-like character seen in the ribs of Cromagnon people and also in modern peoples, particularly in those of the white races.

E. Limbs; Shoulder and Pelvic Girdles.

43. The *leg* (tibial segment) of Neanderthal people was short as compared with the length of the thigh, a relationship which Boule regards as a 'special' feature—but it is also true of most Mongolian peoples. Among the Mount Carmel people the leg was relatively long. There was a high degree of variability in the absolute and relative lengths of the various segments of the limbs among the Mount Carmel people.

44. 'The clavicles were long and slender.' The *clavicles* of the Mount Carmel people are—compared with those of modern people of equal stature—rather short; they are relatively slender and their shafts are flattened in a cranio-caudal direction. In this they resemble the peoples of Krapina. Only a fragment of the clavicle of the Tabūn woman is preserved; in its characters it resembles the Neanderthal clavicle.

45. On the dorsal aspect of the *axillary border* of the La Chapelle *scapula* there is a peculiar groove or fossa which we may speak of as 'Boule's fossa'. This is very well defined in the scapula of the Tabūn woman; it is not so well demarcated in Skhūl V; it is absent in Skhūl IV. It is absent in the scapulae of anthropoid apes and usually absent in scapulae of modern races, although traces are occasionally to be noted. It is present in one Krapina scapula and absent in another. The functional significance of the fossa

is obscure, but it represents a specialization rather than an atavism. Its presence in the Tabūn woman is noteworthy; so are the transitional forms in the Skhūl scapulae. In form of axillary border modern scapulae retain the anthropoid type.

46. It may be that the *acromial* and *coracoid processes*, which are incomplete in our specimens, did possess points which might separate the Mount Carmel scapulae from those of Neanthropic scapulae. In the body and other parts of the scapula we can detect no diagnostic mark.

47. The *long bones* of the extremities are robust in Neanderthal man. This is true of the bones of the lower limbs of Mount Carmel man, but the long bones of the upper extremity are relatively slender—as were those of the Krapina people.

48. The *distal end* of the Mount Carmel *humerus* is wide and the *proximal end* large in relationship to the circumference of the mid-shaft but not in relationship to the length of the bone.

49. The Skhūl *humerus* is long and straight; in its form and markings it is totally unlike that of Neanderthal man. The humerus of the Tabūn woman, on the other hand, has certain resemblances to the Neanderthal type, especially in its great medial epicondylar process. In the Mount Carmel humerus the olecranon fossa is larger than in the modern humerus—a Neanderthaloid feature.

50. Boule describes the shaft of the *radius* as greatly curved. This is so in the Tabūn woman and in a Skhūl woman (No. VII), but the radius of the Skhūl men is remarkably straight.

51. The *bicipital tuberosity* in the Neanderthal radius is placed more towards the dorsal aspect of the shaft, 'tournée vers l'intérieur', than in the modern radius. In this feature the Mount Carmel radius resembles the Neanderthal.

52. In the *ulna* of the Neanderthal man there is a pre-coronoid ridge, and medial to it a pre-coronoid fossa into which the brachialis is inserted. In the modern ulna this fossa has become filled up by bone in the same manner as the genial fossa of the mandible has been filled. The fossa is present in the Tabūn woman, and it is filled up to varying degrees in the Skhūl ulnae. The fossa is present in the ulna of the chimpanzee and represents the primitive form; the filled-up condition represents the evolved type. The Skhūl people show evolutionary stages in the process of filling up.

53. Boule describes the *olecranon process* as very prominent. The length of the olecranon in the Mount Carmel ulnae bears the same proportion to the length of the shaft as it does in modern bones. Nevertheless the olecranon of the Mount Carmel people has certain peculiar features. That of the Tabūn woman has certain resemblances to the olecranon of the chimpanzee; those of the Skhūl ulnae, although they have certain peculiarities of shape and muscular markings, lead on to the modern form.

54. Boule found that the *shaft* of the *ulna* may be prismatic in section, having thus three borders, as in modern man, or only one—the interosseus. The same variation in the definition of borders is found in the Mount Carmel ulnae.

55. 'The Neanderthal *hand* is short and wide' (Boule). This is not so in the Mount Carmel people; the hands of the tall Skhūl men are very similar in size and in proportions to those of the tall Cromagnon men. That of the Tabūn woman is similar in size and proportions to the hand of a male Australian aborigine.

56. The Neanderthal *thumb* is short. In the Mount Carmel people the thumb is only

relatively short, and falls well within the range of variation met with in the hands of modern people.

57. The *metacarpal* of the *thumb* of the Tabūn woman has peculiar features. These are not present in the corresponding metacarpals of the Skhūl men, which are relatively thick for their length.

58. The *carpal bones* of the Tabūn woman have many peculiar and primitive characters. The pisiform differs altogether from the modern pisiform; the unciform has a very long process; the os capitatum and naviculare possess certain anthropoid features. The os capitatum of Krapina man has similar markings. The carpal bones of the Skhūl man, although they possess some of the Tabūn features, are modelled on modern lines.

59. The *iliac parts* of the Neanderthal *os coxae* are 'long, wide, and flat'. In the Mount Carmel people these are short (low)—in Skhūl V very short or low. The iliac crest is less curved than in moderns. In all, the iliac bar (a purely human character), which ends in the tuberosity of the iliac crest, is well developed and lies more anteriorly—nearer the anterior-superior spine—than in the modern os coxae.

60. The *anterior-inferior iliac spine* in Neanderthal man is 'massive', and at its dorsal side there is a 'cupule' or excavation. This is also the case in the Mount Carmel people.

61. 'Épine sciatique très faible . . . caractère pithécoïde.' The lowness of the *sciatic spine* is one of a series of features which characterize the ischial region of Neanderthal and Mount Carmel os coxae. In the modern bone there is below the sciatic spine and above the ischial tuberosity a deep groove for the tendon of the obturator internus. In the Neanderthal and Mount Carmel os coxae this groove lies on the medial border of the ischial tuberosity, the tuberosity, unlike that of the modern bone, almost continuing the line of the ventral border of the great sacro-sciatic notch as in the anthropoid pelvis. We found approaches to the Neanderthal form in the pelvis of the Bushman used for purposes of comparison.

62. The *ramus* of the *pubis* of the Tabūn woman—like her pisiform bone—is altogether peculiar. It forms a flattened plate—recalling features of the anthropoid pubis. The pubic element of the Skhūl pelvis is shaped as in the pelvis of modern races.

63. The *extremities* of the *femur* of Neanderthal man are large in comparison with its length. In the Mount Carmel people the relationship of extremities to length is as in modern races.

64. In the Neanderthal *femur* the shaft is usually curved, the linea aspera low, and the m-l. diameter is usually greater than the a-p. diameter. The Mount Carmel femur is usually straight, its linea aspera usually well developed, and the m-l. diameter is less than the a-p. diameter. But amongst the Mount Carmel people exceptions occur—the linea aspera may be absent or it may form a high crest. The femur of the Tabūn woman is the most Neanderthaloid of the Mount Carmel series.

65. The femoral shaft—from the Upper Acheulean stratum of the Tabūn cave—and the earliest remnant of man from that cave—has Tabūn characters.

66. Boule describes the characteristics of the *proximal end* of the *femur* of Neanderthal man as follows: 'Neck short, head sharply separated from neck; neck nearer to the horizontal in its direction, great trochanter reaches almost to the level of the head.' We have been unable to detect a character or any series of characters which serve to separate the proximal end of the Mount Carmel femur from that of modern femora and yet we

do recognize that the conformation of the upper end of the Mount Carmel femur approaches the Neanderthal type.

67. In the Mount Carmel and Neanderthal femora the *small trochanter* is massive and the *digital fossa* at the medial base of the great trochanter is capacious. This statement is more applicable to the Tabūn femur than to that of the Skhūl men.

68. 'Very often there is a third trochanter and a hypotrochanteric fossa.' This description which Boule applies to the Neanderthal femora holds true of the Mount Carmel femora and also of many femora of modern peoples. The *third trochanter*, the great *gluteal ridge* or flange, with the *hypotrochanteric fossa* of the Düsseldorf femur we regard as evidence of a great development of the gluteus maximus in that individual. Actually, the form taken in this region of the Mount Carmel femur and which receives the gluteal insertion is much closer to that seen in the Cromagnon femur than to that of the Düsseldorf femur.

69. In the evolution of the *anterior ligamentous markings* of the proximal end, the condition in the Neanderthal femur is intermediate to the state in the gorilla and that seen in the Mount Carmel femora. The Mount Carmel condition leads on to the state seen in the femur of living races.

70. The *distal end* of the Neanderthal *femur*—particularly in the forward prominence of its lateral condyle and in the wide, deep groove for the patella—differs from the corresponding parts of the femora of living races. The Mount Carmel femora have intermediate characters.

71. The Neanderthal *tibia* is robust, particularly as regards its articular extremities. Its shaft is three-sided. The Mount Carmel tibia is also robust, three-sided, but its extremities have the same proportion to the shaft as in modern bones.

72. The *proximal end* of the Neanderthal *tibia* is strongly retroverted. The Mount Carmel tibia has a straight diaphysis, and the proximal end is retroverted to a less degree than in many modern races.

73. A very definite mark of the modern tibia is its clear demarcation of an anterior crest or *shin*. A stage in the evolution of the modern shin is seen in the Mount Carmel tibia; it is a stage above that seen in the Neanderthal tibia, which in turn represents a stage leading down to the form seen in the gorilla.

74. *Platycnemia* and *platymeria* are met with amongst the Mount Carmel people.

75. 'The *angle of torsion* is usually small' in the Neanderthal tibia. This is also true of the Mount Carmel tibia, but the degree is nearer to that found in the tibia of living races.

76. The *distal end* of the Mount Carmel *tibia* resembles the Cromagnon tibia much more than the Neanderthal. It carries a 'squatting facet'.

77. The Neanderthal *fibula* is 'robust, shaft rounded, incurved'. The fibula of the Mount Carmel people is very straight, the upper part of the shaft slender, the middle part having four surfaces of about equal size. We found no point which serves to distinguish the Neanderthal, Mount Carmel, and modern fibulae from each other.

78. The *astragalus* (talus) of the Neanderthal species is 'very short, very wide, very high, with its neck at a considerable angle and the facets for the malleoli extensive'. The Mount Carmel astragalus differs from the Neanderthal in all of these points; indeed, we have discovered no certain way of distinguishing the Mount Carmel astragalus from that of living native races.

79. The Neanderthal *calcaneus* is 'wide, has a greatly developed sustentaculum tali, the axis of the heel is directed upwards and outwards towards the fibula'—instead of towards the tibia as in modern man. In the Mount Carmel calcaneus we find that all its resemblances are towards the modern calcaneus and away from the Neanderthal. We infer that the Mount Carmel people used their heels as modern races do—they stood and walked in the modern way.

80. In the Mount Carmel calcaneus there is illustrated a stage in the evolution of the *lateral tuberosity* of the human *heel*. In this the Mount Carmel calcaneus is intermediate in position to the Neanderthal and modern bones.

81. In the Mount Carmel *navicular*, *cuboid*, and *cuneiforms* we meet with certain peculiarities, but no feature which serves to distinguish them from the same bones in the feet of modern native peoples.

82. The Neanderthal *metatarsal bones* are 'short, robust, with large distal ends'. In length, strength, and proportion of parts the metatarsal bones of the Mount Carmel people agree with those of the feet of Cromagnon people and other robust Neanthropic races.

83. The Neanderthal *great toe* is 'very short'. Amongst the Mount Carmel people the great toe, although shorter than the second, is not more so than is found in some modern peoples.

84. The *angle* at which the *great toe* was placed and its relationships to the other toes are those found in modern native peoples.

85. The *first metatarsal* of the Skhūl men is relatively short and exceedingly stout, while that of the Tabūn woman has a close resemblance in form and in its articulations to the condition found in the feet of the modern Bushman.

86. The *arch* of the *foot* amongst the Mount Carmel people was as well developed, both in a longitudinal and a transverse direction, as in modern native peoples—such as Australian aborigines and the Bushman.

Summary of Characters.

In the above list we have discussed 86 skeletal characters of the Mount Carmel people. Nearly all of these are characters which have been considered by Boule. We have borrowed from his list the characters of the Neanderthalians of Western Europe. In our first list (pp. 359–60), which includes those features which are diagnostic of the Neanderthal species, we have tabulated 25 characters of the Mount Carmel people. These are classified under the following heads: Neanderthal, 3; Neanthropic (Cromagnon), 8; intermediate, 11; indeterminate or general, 3. We shall now divide the characters in our second list under the same headings. The result is: Neanderthal, 13; Neanthropic, using the Cromagnon people as representative of this type, 24; intermediate, 35; indeterminate, 10. To these we must add a small fifth group—characters peculiar to the Mount Carmel people (4)—namely, the shape of the clavicle, the form of humerus, the form of the iliac basin, and the small size of the atlas and axis.

When we add the two lists to obtain a final result, we have 111 characters distributed as follows: Neanderthal, 16 (14·4 per cent.); Neanthropic, 32 (28·8 per cent.); intermediate, 46 (41·4 per cent.); indeterminate, 13 (11·7 per cent.); peculiar, 4 (3·6 per cent.).

If we are to be guided entirely by this census of characters then we must count the Mount

Carmel people to have a greater resemblance—to be much more akin—to an early Neanthropic people—the Cromagnons—than to the Neanderthal people of western Europe. For our table shows that Neanderthal characters, and *quasi*-Neanderthal characters, make up only 55·8 per cent. of the total, while Neanthropic, and *quasi*-Neanthropic features, amount to 70·2 per cent. of the total. This must be our final conclusion if we regard every character in our list as of equal value. We do not believe that characters are of equal value when we come to adjudicate on the genetic relationship of one human race to another. A very large proportion of the Neanthropic characters of the Mount Carmel people lies in the conformation of their limb bones. Such characters form a functional group which must undergo correlated changes—all directed towards the fulfilment of the purposes for which limbs are used. By counting each character as of equal value we give the minor correlated or plastic features an unfair representation. We feel that dental characters—such as the cusp arrangement of the incisors, premolars, and molars—have a greater taxonomic value than the anatomical features of the femur. So, too, with the supra-orbital torus, the form of the malar, the width of the great wing of the sphenoid, and certain features of the carpal bones; these seem to us to be the more reliable 'sign-posts'.

Two other considerations weigh with us in placing the Mount Carmel people in the Palaeoanthropic genus and not in the Neanthropic. The first is the great number of their characters which are intermediate, namely, 41·4 per cent. The second is this: we feel certain that when the limb bones of the Krapina people—certainly a Palaeoanthropic people—are better known, they will show many more resemblances to those of the Mount Carmel people than to the Neanderthalians of Western Europe.

There is, too, an important matter to be mentioned about the characters we have classified as intermediate. First, there are those of a true transitional kind—such as the size and shape of the squama of the temporal, the nuchal impressions of the occipital, the spines of the cervical vertebrae, characters at the upper end of the femur, and in the characterization of the calcaneus. But in the same group we have also included such features as the mastoid process—which is Neanderthal in form and size in the Tabūn woman and in a Skhūl woman (VII), but is purely Neanthropic in the Skhūl men, particularly in Skhūl VI. Or take the chin: it is absent in the Tabūn woman and every grade in its earlier evolution is found in the other mandibles. A great number of our intermediate characters are intermediate in that they form units of an intermediate series. The Mount Carmel people collectively possess intermediate states which bridge the structural hiatus lying between the Neanderthal and Neanthropic types.

We have already given it as our opinion that Mount Carmel man has come by his Neanthropic characters—not by hybridization—but by a natural and separate evolutionary history. The abundance of Neanthropic characters in Mount Carmel man is an indication, we think, that he broke away from the stem of mankind emerging in western Asia during early Pleistocene times, at a date later than did the ancestral stock of the Neanderthals of western Europe. Being later in his separation, Mount Carmel man has thereby come to have a larger share of Neanthropic characters of the stock which ultimately produced the Cromagnon and other Neanthropic types.

We have not drawn up a list of the points in which the Tabūn woman differs from the Skhūl people. In every chapter we have discussed their differences. There are, however,

two anatomical features of the Tabūn woman which demand particular consideration. These are the peculiar form taken by the pubic part of her pelvis and the strange shape given to her pisiform. We find it very difficult to believe that these are mere individual anomalies; they have all the appearance of intrinsic structures of morphological value. Only future discoveries can resolve the problem of her position—whether an individual sport, or a representative of a distinct race.

One point more remains to be mentioned. We have presumed—whenever we have discussed the Tabūn and Skhūl types—that the Tabūn was the more primitive and therefore the earlier. Is this assumption justified? Miss Garrod draws attention to the possibility of the Tabūn woman being later than the stratum in which her remains were found. She might therefore be later in date than the Skhūl people. The teeth and jaws of the child found in the upper stratum (B) of the Tabūn cave have all the characters of the Tabūn type but the deposit in which they were found is later than that in which the Tabūn woman was interred.

In rejecting the idea that the Tabūn people came after those of the Skhūl type we are guided by the very primitive features of the mandible known as Tabūn II and the similarity of its teeth to those of the Tabūn woman; it is hard to believe that the mandible of the Tabūn man could represent people which lived later than the Skhūl people. Miss Garrod found fragments of the people who lived in the Tabūn cave at a very early period—towards the close of the Acheulean. These fragments—a shaft of a femur and a worn molar—indicate a people of the Tabūn—not of the Skhūl type. This fact also supports the idea that the Tabūn type is the older.

Injuries and Diseases of the Mount Carmel People.

Discussing the industry of the Neanderthalians of Europe, Boule has written, 'L'utilisation d'une seule matière première (en dehors du bois et peut-être de l'os), l'uniformité, la simplicité et la grossièreté de son outillage lithique . . . s'accordent bien avec l'aspect brutal de ce corps vigoureux et lourd.' The Mount Carmel people, assigned to an earlier geological period than the Neanderthalians of Europe, were better equipped. A wound of the left hip joint of the strong Skhūl man (IX) gives unequivocal testimony to their possession of spear-like weapons of great penetrating power (see Pls. VIII c, XXVIII a, b, c). The injury, described on pp. 74–5, was caused at death or soon after death. The weapon pierced and shivered the whole thickness of the head of the femur, the floor of the acetabulum, and entered the pelvic cavity. After the matrix had been cleaned out of the track of the weapon it was possible to obtain a cast which reproduces the shape and the size of the bony cavity formed by the implement (Pl. XXVIII c). The penetrating part of the weapon evidently became broken from the shaft; at least this part remained embedded in the wound and became surrounded by a coating of stalagmite. Had the head of the weapon been made of stone or bone it would have persisted, just as the bone around it has been preserved. We infer that it was made of hard wood, perhaps fire-hardened. To cause such an injury the weapon must have had a hard and resistant point and the man who used it must have had great strength.

The skull of the same man shows an extensive injury (Fig. 201 and Pl. XXI c). A close examination of the margins of the injury leads us to think that it was caused by a glancing blow at, or soon after, death. The evidence in this case is not unequivocal.

The body of the child, Skhūl I, shows three injuries which were inflicted at death, or not unlikely at some time soon after death, but before the bones had become mineralized. The injuries affect the forehead, the right temporo-mandibular region, and the lower dorsal region of the spinal column. They are described in detail on p. 301.

The distal halves of metatarsals II and III of the left foot of Skhūl IV show evidence of having been broken obliquely, followed by good union. From the site of fracture on each side of the second space there has been a bony outgrowth. These outgrowths come into contact but have not united (Fig. 1 c and Pl. II A).

There is no trace of caries in any of the teeth from the Tabūn or from the Skhūl caves, there are few signs of alveolar abscesses and very few teeth have been lost during life.

The roots of the lower molar teeth of Skhūl IV are exposed owing to a depression of the alveolar bone which surrounds them. This seems to have been due to 'packing' of food rather than to pyorrhea alveolaris. Indeed, there is no certain evidence of the latter disease.

The crowns of the teeth show varying degrees of wear, but none manifest the degree of erosion often met with in the dentitions of modern native peoples. When we regard their probable age, the teeth of the Skhūl men are remarkably little worn.

The second premolars in Skhūl IV, both upper and lower, are malposed (p. 202), an anomaly which occurs in modern races. In a lower jaw found at Krapina the first premolar shows a similar malposition.

The absence of rheumatoid changes in the joints is quite remarkable. Only two joints are the seat of such changes: the left temporo-mandibular joint of Skhūl VII (female) and the same joint on the right side in Skhūl V. It will be remembered that the large Krapina mandible (I) was the subject of this disease. It is not uncommon in the skulls of native peoples in which the teeth are deeply worn.

Longevity.

Recently Professor H. Vallois (1937) has drawn attention to the high rate of mortality amongst races of the Pleistocene period. Relying on the degree to which cranial sutures had closed and the extent of wear of the teeth as guides to age, he came to the conclusion that old age, as we know it, was never reached by Palaeolithic man. The evidence from Mount Carmel has led us to a similar conclusion. We have grounds for assessing the age at which twelve individuals of the Mount Carmel population died. Four died in childhood (Skhūl I, VIII, X, Tabūn Series I) ranging from 4 to 10 years. One was under thirty (Tabūn I); five were between 30 and 40 (Tabūn II, Skhūl II, V, VI, VII), one was over 40 and under 50 (Skhūl IV), and only one (Skhūl IX) was over 50. We leave to statisticians the task of calculating the expectation of life, and the birth-rate that was needed to maintain even a stationary population in this Palestinian community of the last or Riss-Würm interglacial period.

APPENDIX I

TECHNICAL PREPARATION AND TREATMENT OF THE FOSSIL SPECIMENS

We feel that it may be of interest and value to note briefly the methods we have used in the treatment and preparation of the fossil specimens. The excavation of the bones from the breccia matrix need not be described here. It may be well to explain that breccia consists of cave earth solidified mainly by calcium carbonate and that the latter has penetrated the bone. We found it impossible to treat the bony specimens with any form of acid; the matrix had to be removed entirely by mechanical means. We succeeded in doing this without crushing or seriously damaging the actual specimens. The Tabūn fossil bone is very definitely harder and more dense than that from the Skhūl cave; it is actually harder than the steel chisels and points which were used to remove the matrix. The same condition of affairs was very apparent with regard to Skhūl IX, but the other specimens from the Skhūl cave had to be treated very carefully. All of the bones are inclined to be rather brittle, few of them being of a water-biscuit consistency, and all of them are so dense that artificial hardening was unnecessary. Repairs were made with two kinds of material—the first being sheet celluloid dissolved in acetone and amyl acetate. This material is soluble in acetone. For defective areas we have used ordinary plaster of paris for repairing and strengthening the parts, the front of the cranium of Skhūl V, for instance, being held in position by this material.

The brittle nature of the bone appeared to cause the surface to flake away in certain of the specimens and to counteract this we have used a nearly transparent cellulose lacquer. This is also soluble in acetone.

APPENDIX II

HUMAN REMAINS FROM UPPER PALAEOLITHIC STRATA OF MUGHARET EL-WAD AND KEBARAH

The Upper Palaeolithic strata of the Mugharet el-Wad were very barren with respect to human remains. The fragments which we shall describe presently came from Layers D 1, D 2, and E of the Mugharet el-Wad, and we have noted, in addition, certain fragments which Mr. Turville Petre recovered from the Aurignacian levels of Kebarah. The number of these is so few that we feel it better to present a short record of them now rather than to wait until some future time when material from this part of the Stone Age of Palestine becomes more abundant.

Layer E (middle Aurignacian) of Mugharet el-Wad yielded eight isolated teeth. There are two teeth from Layer D 2 and a lower premolar from Layer D 1. The actual list of teeth with their accompanying measurements are given in Table LXXXVII (p. 379). It will be noted at once that the measurements fall well within the range for those of modern teeth and our comparison of the individual specimens with modern teeth and with isolated teeth from the Tabūn cave make it evident that in no way do they differ from the teeth of Neanthropic man. The upper left third molar from Layer E has a peculiar lozenge-shaped root, conjoined except at the tips, and is very short. Some of the teeth show considerable wear. In no case is this exceptional.

As to other specimens, it will be most convenient to mention them in connexion with the Layers from which they were obtained. There is an atlas of a light brown colour not deeply mineralized from Layer D 1. It probably belonged to a female. There is no trace of a spinous process on the posterior arch, and the tubercle on the anterior arch is low and conical. The groove for the vertebral

artery on the posterior arch is wide and shallow. The articular facets for the occipital condyles measure: maximum length, 24 mm.; maximum breadth, 11·6 mm. The maximum antero-posterior diameter of the whole vertebrae is 41·5 mm. and its greatest transverse diameter—between the lateral margins of the articular processes for the axis—is 51 mm. The transverse diameter between the internal tubercle of the condyles is 17 mm. The posterior arch is 6·5 mm. thick at the mid-point and the anterior arch is 6 mm. thick. The respective heights are 9·2 and 10·6 mm.

The articular surfaces for the atlas slope inwards and downwards rather sharply, are kidney-shaped, and deeply convex from front to back.

There is a fragment of the right half of a mandible carrying the alveoli for the molars and the premolars. Only the M-1 is present, so deeply worn that the dentine is exposed over nearly the entire occlusal surface. The colour is greyish brown. Compared with similar parts of Fragment 1 from Layer E the dimensions of both teeth and jaw appear to be approximately the same. The thickness of the fragment at the mentale is 13·9 mm.

Layer E.

We shall consider first the miscellaneous bones of the limbs and trunk found in this Layer and then pass on to the mandibular fragments. There is a fragment of the anterior crest of a tibia, probably of the right leg. This thick and moderately mineralized fragment measures 83 mm. in length.

There is a fragment of the body of a lumbar vertebra. The estimated width of the caudal aspect of the body is 38 mm. and the anterior height is 29·5 mm.

There is a terminal phalanx of a right hand. Its length is 24 mm., and the diameters of the base are: transverse, 15 mm.; dorso-volar, 9 mm. The subungual termination is narrow and not expanded.

There is a proximal phalanx of a right hallux with a length of 30 mm., the diameters of the base being, transverse, 19·5 mm.; dorso-volar, 16·5 mm. The shaft measures 13 × 9·5 mm. The bone is a grey-brown colour, and the specimen is not deeply mineralized.

The shaft and base of a third left metatarsal were recovered from Layer E. The articular surfaces of the proximal end do not differ appreciably from those of the Sikh used for comparisons for the chapters in this volume. The diameters of the proximal articular end are: transverse, 15·4 mm.; dorso-volar, 20·5 mm.; at the mid-shaft, the transverse diameter is 7 mm., the dorso-volar diameter, 11·3 mm. The bone is light brown and not deeply mineralized.

There is a nearly complete left talus, probably male. The length is 54 mm.; the width, 44 mm.; the long diameter of the trochlear articular surface is 33 mm., and its width 32 mm. The diameters of the head are 32 × 25 mm., and the calcaneal articulation measures 31 × 23 mm.

When the specimen rests on a plane surface the lateral and medial margins of the trochlea appear to be on the same level. The neck is short; there is no 'squatting facet' and the sub-capitular fossa is weakly developed. There is a rough posterior border, probably for the os trigonum.

Fragment 1. The first of the mandibular fragments consists of the greater part of the right half including the forward part of the ascending ramus, the mental element and also the alveolar part which carries the incisive teeth (cf. Keith, 1931, p. 220). The teeth are worn, exposing a crescent of dentine. The total length of the three molars is 34·8 mm. Pits on the buccal aspect of the molars are well marked. The estimated length from the mental foramen to the posterior border of the ramus is 74 mm.; the thickness at the symphysis is 18·5 mm., and at the mentale the thickness is 13 mm. The mylo-hyoid ridge is weakly marked, but the genial spines are prominent though rather small. The mental prominence is median and moderately developed.

Mandibular Fragment 2. This consists of the left half of an immature mandible extending from the mental eminence backwards to include the anterior part of the ascending ramus. The third molar is unerupted and apparently deeply buried. The second molar is up but the wear on the crown is slight.

We ascribe this to a female, probably fourteen or fifteen years of age. The mental eminence is very similar in its conformation to that in the fragments previously described.

In none of these fragments is the degree of mineralization equal to the Levalloisian specimens, nor have they the assemblage of anatomical features which is so distinctive of the Levalloiso-Mousterian human remains.

Kebarah fragments.

The human remains from the Upper Palaeolithic deposits excavated by Mr. Turville Petre at the cave of Kebarah consist of the distal ends of a right and left humerus. There is the proximal end of a right ulna and the proximal end and more than half the shaft of another right ulna. There are five mandibular fragments, three of them belonging to adults, two of them to children.

The two humeral fragments quite evidently belong to different individuals, the right one being appreciably larger than the fragment of the left bone. The epicondylar breadth of fragment No. 1 is 58 mm., the width of the trochlea is about 28 mm., and its depth 24·5 mm., the capitulum having been broken away. The diameters of the shaft, 50 mm. above the upper border of the olecranon fossa, are: dorso-ventral, 17 mm.; transverse, 19 mm. The olecranon fossa has a transverse diameter of 26 mm., and a depth of 6 mm.

Fragment No. 2 has an epicondylar breadth of 55·5 mm. and the capitulum 40 mm. The depth of the trochlea is 22 mm. The shaft diameters at the upper end of the fragment are 22 mm.; above the olecranon fossa the dorso-ventral diameter is 23 mm., the transverse 18 mm.; the diameters of the olecranon fossa are: transverse, 23·5 mm.; depth, 7 mm. The shaft of this fragment shows the traces of gnawing by some small carnivore or rodent, probably the latter. In neither fragment is the olecranon fossa perforated. The first is probably that of a man, the second of a woman.

The first of the two ulnar fragments is 85 mm. long; the height of the olecranon, 23 mm.; its transverse diameter 24 mm., and its depth 25 mm. The breadth of the coronoid is 21·5 mm., and its depth 15·5 mm. The articular surface for the head of the radius is a small narrow square area, 12×10 mm. The tuberosity is moderately developed, and the supinator crest is of the degree of development seen commonly in modern bones. The other ulnar fragment (No. 2) has a total length of 163 mm. The height of the olecranon is 25·5 mm., but its breadth and depth cannot be determined because part of the process is damaged. The coronoid has a depth of 14 mm., and a breadth of only 16·5 mm. The radial notch is an oval, deeply concave area 17 mm. long×9 mm. high. The maximum diameter of the shaft at the point of maximum development of the crest is 16 mm., and the minimum diameter is 13·7 mm. The tuberosity is rather prominent, and the supinator ridge is not only prominent but runs downwards to become fused with the interosseous crest of the shaft.

Mandibles.

Fragment No. 1 consists of the symphysial portion of an adult mandible extending from a point just behind the mental foramen on the right side to the mental foramen on the left side. It carries the alveoli for the teeth from the Pm-2 right to the Pm-1 left. The height of the symphysis is 29 mm., and the thickness is 13·6 mm. The bi-mental diameter is 42·8. The chin eminence consists of a median prominence sloping away at either side. The genial spines are represented by two low flat tubercles divided by a medium fissure. There is a minute vascular foramen above the ridges. The sublingual fossae are well marked owing to the prominence of sublingual shelves—a relic of the simian shelf.

Fragment No. 2 comprises the greater part of the right half of an adult mandible. The M-1 has been lost, due to an abscess at the root. Only M-2 and M-3 are preserved, and they are so worn that the dentine is exposed over the greater part of the chewing surface. The depth of the mandible at the mental foramen is 30 mm. and its thickness 11·7 mm. At M-3 these measurements are

23·5 mm. × 14·6 mm. The anterior margin of the ascending ramus is defective. We estimate the minimum width of the ramus to have been 33·5 mm. The roots of the M-2 are exposed beyond the normal, due probably to a slight degree of pyorrhea. The mylo-hyoid ridge is not greatly developed, and the mandibular canal is carried downwards in the form of a channel of which the middle part is roofed over for a distance of 5 mm.

Fragment No. 3 is part of the mandible of a child aged about ten years. The fragment of the corpus of the right side carries the alveoli from the canine to the third molar, but only the first molar is in position. The depth at the M-2 is 19·5 mm.; the thickness 15·4 mm., while the thickness at the mental foramen is 12·5 mm.

Fragment No. 4. This mandible, which we regard as that of a child aged about twelve years, is complete except for the left ascending ramus. The canine and the Pm-2 are just appearing at the alveolar margins. M-3 is still in its alveolus. M-2 is fully erupted, but just becoming functional; over the erupting Pm-2 is the remnant—a mere shell—of the m-2, worn to the roots by use. The thickness at the symphysis is 14 mm. The thickness of the mandible at the mentale is 12·1 mm., while the heights at the symphysis and the mentale are 22·2 and 23 mm. respectively. The genial fossa is almost filled by a triangular eminence, and the sublingual fossae are clearly indicated. This specimen is not as heavily mineralized as the three fragments previously described, being in its colour and character similar to the fragment which we are now to discuss.

Fragment No. 5. This is an almost complete lower jaw except for the right ascending ramus. It probably belonged to a female. The crowns of the molars are worn flat, exposing crescents of dentine at the bases of the cusps. The age is probably about thirty-five years. The third molars are absent, apparently having never been developed. All of the teeth are present except the left second premolar, which has been lost *post mortem.* There is no caries, but on the lingual aspect of the roots of the medial incisors there is an opening of an abscess cavity. The measurements of this and of the other more complete mandibular fragments are given in Table LXXXVIII (p. 379). The coronoid process on the left side is not intact, but it must have been of a slender and pointed character. There is a very noticeable inversion of the gonial angle with a prominent rugose ridge on the inner surface for attachment of the pterygoid. The characteristic feature of this specimen is that the incisor teeth rise up to form an arch, the crowns of the medial incisors forming its apex. This feature, combined with the absence of wear on the incisors, we attribute to the extraction of the upper medial incisors during life. In the pattern of the incisor arch this specimen can be duplicated from mandibles known to belong to the Natufian Layers of both Kebarah and the Mugharet el-Wad. Furthermore, this specimen is not as heavily mineralized as the other fragments from Layer D of Kebarah, described above, with the exception of mandible fragment No. 4. We therefore suggest that there is a possibility that this specimen belongs to the Natufian deposits at this site.

The extreme scarcity of human material from the Upper Palaeolithic layers of the Mount Carmel caves is a great misfortune, but it is to be hoped that excavation elsewhere in Palestine will more than fill in the gaps in the sequence of the human types who have dwelt in the Holy Land.

Table LXXXVII. AURIGNACIAN TEETH

MUGHARET EL-WAD

	Layer E								D 1	D 2	D 2
	c	*I-1*	*I-2*	*Pm-2*	*Pm-1*	*Pm 2*	*M 1*	*M-3*	*Pm 2*	*M-3*	*M 3*
	R	R	R	R	R	L	R	L	R	R	L
Crown diameters:											
medio-distal	7·1	5·3	6·7	5·9	..	7·5	12·2	9·2	7·2	12·2	12·1
labio-lingual	5·5	6·7	7·0	9·2	..	8·9	11·4	12·3	8·5	12·0	12·0
Crown height	7·2	7·0	8·0	7·2	6·1	7·2	7·0	7·2	5·2	8·6	8·6
Root length	..	15·2	16·0	(11·0)	18·1	..	14·0	13·4	..	19·0	17·7
Total tooth length	..	21·3	23·1	(19·0)	23·2	..	20·3	20·0	..	25·4	24·4

	M. EL-WAD						KEBARAH							
	Fragment 1						*Fragment 5*					*Fragment 4*		
	M-1	*M-2*	*M 3*	*I-1*	*I-2*	*C*	*Pm-1*	*Pm-2*	*M-1*	*M-2*	*C*	*Pm 2*	*M-1*	*M-2*
	R	R	R	R	R	R	R	R	R	R	R	R	R	R
Crown diameters:														
medio-distal	12·5	11·0	11·4	5·5	6·1	6·7	7·3	7·0	10·9	11·1	7·2	7·2	11·5	10·8
labio-lingual	11·1	11·0	10·6	6·2	6·2	7·3	7·7	8·4	11·2	11·0	7·1	8·2	10·1	10·2
Crown height	4·1	5·0	5·0	8·9	7·3	8·6	6·4	5·0	4·8	5·2	8·5	9·2	7·6	8·1
Root length	..	..	..	..	..	14·0	12·6	..	..	..	..	..	..	..
Total tooth length	..	..	..	..	..	22·7	18·5	..	..	..	..	..	..	..

Table LXXXVIII. AURIGNACIAN MANDIBLES

	M. el-Wad. Layer E		*Kebarah*		
	No. 1	*No. 2*	*No. 5*	*No. 4*	*Australian*
Lengths:					
maximum M 68(1)	(95·0)	..	(100·0)	(84·0)	105·0
gonial M 68	(70·0)	..	(74·0)	(60·0)	81·0
Widths:					
bicondylar M 65	(110·0)	..	(120·0)	(114·0)	125·0
bigonial M 66	(90·0)	..	(80·0)	(80·0)	100·0
bi-mental M 67	..	..	44·0	39·6	48·0
Ratio:					
max. length–bicond. width	86·3	..	83·3	73·6	84·0
gonial length–bicond. width	63·6	..	61·6	52·6	64·8
Heights:					
symphysis M 89	30·0	(26·5)	29·1	22·2	31·2
at M–2 M 69(2)	27·3	26·2	(21·3)	20·7	25·6
Thickness:					
at mentale M 69(3)	13·0	15·3	8·8	12·1	14·0
at M–2	14·5	17·0	13·0	15·4	15·5
Ascending ramus:					
height M 70a	..	..	51·0	(43·0)	..
min. width M 71a	..	..	33·5	29·1	37·5
Gonial angle M 79	..	..	117·5°	128·5°	115°

BIBLIOGRAPHY

Adloff, P. (1907). 'Die Zähne des Homo primigenius von Krapina, &c.' *Zeit. f. Morph. u. Anthrop.*, vol. x, p. 197.

—— (1908). *Das Gebiss des Menschen und der Anthropomorphen* (Berlin).

—— (1931). 'Über den Ursprung des Menschen im Lichte der Gebissforschung.' *Schriften der Koenigsberger Gelehrte-Gesellschaft, Natur. Klasse*, vol. viii, p. 299.

—— (1934). 'Das Tuberculum molare des ersten Milchmolaren, &c.' *Anat. Anz.*, vol. lxxviii, p. 342.

—— (1937). 'Über die primitiven und die sogenannten "pithekoiden" merkmale im Gebiss des rezenten und fossilen Menschen, &c.' *Zeit. f. Anat. u. Entwick.*, vol. cvii, p. 68.

Bate, D. M. A., *see under* garrod.

Bell, Julia, *see under* pearson.

Berry, R. J. A. (1928). *Brain and Mind* (London). See also Keith, 1932, p. 61.

Bolton, J. S. (1910). 'A Contribution to the Localization of Cerebral Function based on the Clinico-pathological Study of Mental Disease.' *Brain*, vol. xxxiii, p. 26.

Bonarelli, G. (1909). 'Palaeanthropus (n.g.) Heidelbergensis (Schoetensack).' *Riv. ital. Pal. Perugia*, No. 19.

Bonin, Gerhardt von (1929). 'Rassenunterschiede der Trochlea Tali.' *Zeit. f. Morph. u. Anthrop.*, vol. xxvii, p. 422.

—— (1935). 'European Races of the Upper Paleolithic.' *Human Biology*, vol. vii, p. 196.

Boule, Marcellin (1911). 'L'homme fossile de la Chapelle-aux-Saints.' *Annales de Paléontologie*, vol. vi.

—— (1923). *Fossil Men* (transl. by J. E. and J. Ritchie (Edinburgh)).

Boule, M., and Anthony, R. (1911). 'L'encéphale de l'homme fossile de la Chapelle-aux-Saints.' *L'Anth.*, vol. xxii, p. 129.

Campbell, T. D. (1925). *Dentition and Palate of the Australian Aboriginal.* University of Adelaide Publications, no. 1.

Clark, W. E. Le Gros, Cooper, D. M., and Zuckerman, S. (1936). 'The Endocranial Cast of the Chimpanzee.' *J. Roy. Anth. Inst.*, vol. lxvi, p. 249.

Cunningham, D. J. (1886). 'The Lumbar Curve in Man and the Apes, &c.' *Royal Irish Academy, Cunningham Memoirs*, no. 2.

—— (1908). 'The Evolution of the Eyebrow Region of the Forehead, &c.' *Trans. Roy. Soc. Edin.*, vol. xlvi, p. 283.

Dawson, C., Woodward, A. S., and Smith, G. Elliot (1913). 'On the Discovery of a Palaeolithic Skull and Mandible, &c., at Piltdown, Fletching (Sussex).' *Quart. J. Geol. Soc.*, vol. lxix, p. 117.

Dubois, E. (1924). 'On the Principal Characters of the Cranium and Brain, of the Mandible and the Teeth of Pithecanthropus erectus.' *Proc. Konin. Akad. Wetensch. Amsterdam*, vol. xxvii, p. 265.

Edinger, Tilly (1929). 'Die fossilen Gehirne.' *Ergeb. d. Anat. u. Entwick.*, vol. xxviii, p. 212.

Fleming, R. M. (1933). *A Study of Growth and Development.* Medical Research Council, Special Report Series, no. 190.

Fraipont, J., and Lohest, M. (1887). 'La race humaine de Neanderthal ou de Canstadt en Belgique.' *Archives de Biologie*, vol. vii, pp. 587–757.

Garrod, D. A. E. (1934). 'Excavations at the Wady al-Mughara (Palestine), 1932–33.' *Bull. Amer. Sch. Preh. Res.*, no. 10.

—— (1935). 'Excavations in the Mugharet et-Tabūn (Palestine), 1934.' Ibid., no. 11, p. 54.

—— (1936). 'A Summary of Seven Seasons' Work at the Wady el-Mughara.' Ibid., no. 12, p. 125.

Garrod, D. A. E., and Bate, D. M. A. (1937). *The Stone Age of Mount Carmel*, vol. i (Oxford).

Garrod, D. A. E., Buxton, L. H. D., Smith, Sir G. Elliot, and Bate, D. M. A. (1928). 'Excavation of a Mousterian Rock-Shelter at Devil's Tower, Gibraltar.' *J. Roy. Anth. Inst.*, vol. lviii, p. 33.

Gorjanović-Kramberger, K. (1906). *Der Diluviale Mensch von Krapina in Kroatien* (Wiesbaden).

—— (1907). 'Die Kronen und Wurzeln der Mahlzähne des Homo primigenius, &c.' *Anat. Anz.*, vol. xxxi, p. 97.

—— (1908). 'Bemerkungen zu: Adloff, "Die Zähne des Homo primigenius von Krapina".' *Anat. Anz.*, vol. xxxii, p. 145.

—— (1909). 'Die verwandtschaftlichen Beziehungen zwischen dem Homo heidelbergensis aus Mauer und dem Homo primigenius aus Krapina in Kroatien.' *Anat. Anz.*, vol. xxxv, p. 359.

—— (1910). 'Zur Frage der Existenz des *Homo aurignacensis* in Krapina.' *Ber. Geol. Kommis. Kroat. u. Slavon.*

Gregory, W. K. (1916). 'Studies on the Evolution of the Primates. Part II. Phylogeny of Recent and Extinct Anthropoids, with special Reference to the Origin of Man.' *Bull. Amer. Mus. Nat. Hist.*, vol. xxxv, p. 239.

—— (1922). *The Origin and Evolution of the Human Dentition* (reprinted from *The Journal of Dental Research*, vols. ii, iii (Baltimore).

Gregory, W. K., and Hellman, M. (1926). 'The Dentition of *Dryopithecus* and the Origin of Man.' *Anthro. Papers, Amer. Mus. Nat. Hist.*, vol. xxviii, p. 1.

Hrdlička, Aleš. (1927). 'The Neanderthal Phase of Man.' *J. Roy. Anth. Inst.*, vol. lvii, p. 249.

—— (1930). *The Skeletal Remains of Early Man. Smithsonian Misc. Collections*, vol. lxxxiii (Washington).

Jeanselme, M. E. (1917). 'Du tubercle de Carabelli, &c.' *Bull. et Mem. Soc. d'Anth. Paris*, (VI), vol. viii, p. 121.

Kappers, C. U. Ariëns (1929). 'The Fissures on the Frontal Lobes of Pithecanthropus erectus Dubois compared with those of Neanderthal Men, &c.' *Proc. Konin. Akad. Wetensch. Amsterdam*, vol. xxxii, p. 182.

—— (1929). 'Further Communications on the Fissures of the Frontal Lobes of Neanderthal Men.' Ibid., p. 196.

—— (1929). 'The Frontal Fissures on the Endocranial Casts of some Predmost Men.' Ibid., p. 552.

—— (1933). 'The Fissuration of the Frontal Lobe of Sinanthropus pekinensis Black, compared with the Fissuration in Neanderthal Men.' Ibid., vol. xxxvi, p. 802.

—— (1936). 'The Endocranial Casts of the Ehringsdorf and Homo soloensis.' *J. Anat.*, vol. lxxi, p. 61.

Kappers, C. U. Ariëns, and Wang, Hwei-wen (1924). 'Some Features of the Parietal and Temporal Lobes of the Human Brain and their Morphological Significance.' *China Medical Journal*, Sept.

Keith, Sir Arthur (1925). *The Antiquity of Man*, 2nd ed., (2 vols.), (London).

—— (1927). 'A Report on the Galilee Skull' in *Researches in Prehistoric Galilee* (published by the British School of Archaeology in Jerusalem). (London.)

—— (1931). *New Discoveries relating to the Antiquity of Man.* (London.)

Keith, Sir Arthur, and McCown, T. D. (1937). 'Mount Carmel Man. His Bearing on the Ancestry of Modern Races.' *Bull. Amer. Sch. Prch. Res.*, no. 13, p. 5.

—— —— 1937. Ibid., in *Early Man* (ed. G. G. MacCurdy). (Philadelphia.)

Klaatsch, H. (1901). 'Das Gliedmassenskelett des Neanderthalmenschen.' *Verh. Anat. Ges.*, vol. xv, p. 121.

Klaatsch, H., and Hauser, O. (1909). 'Homo mousteriensis Hauseri.' *Archiv f. Anthr.*, vol. vii, p. 287.

—— —— (1910). 'Homo aurignacensis Hauseri.' *Prähist. Zeitschr.*, vol. i, pp. 273, 285.

Kramberger, *see under* gorjanović-kramberger, k.

Martin, H. (1923). *L'homme fossile de La Quina* (Paris).

Martin, Rudolf (1928). *Lehrbuch der Anthropologie*, 2nd ed. (Jena).

Matiegka, J. (1925). 'Les Squelettes provenant de la station de l'homme quaternaire à Predmost en Moravie.' *Anthropologie* (Prague), vol. iii, p. 323.

—— (1929). 'The Skull of the Fossil Man, Brno III, and the Cast of its Interior.' *Anthropologie* (Prague), vol. vii, p. 90.

McCown, T. D. (1932). 'A Note on the Excavation and the Human Remains from the Mugharet es-Sukhūl (Cave of the Kids), Season of 1931.' *Bull. Amer. Sch. Preh. Res.*, no. 8.

—— (1933). 'Fossil Men of the Mugharet es-Sukhūl, near Athlit, Palestine, Season of 1931.' Ibid., no. 9.

—— (1934). 'The Oldest Complete Skeletons of Man.' (With a note by Sir Arthur Keith.) Ibid., no. 10.

—— (1936). 'Mount Carmel Man.' Ibid., no. 12.

Morant, G. M. (1927). 'A Biometric Study of Neanderthaloid Skulls, &c.' *Annals of Eugenics*, vol. ii, p. 318.

—— (1930). 'A Biometric Study of the Upper Palaeolithic Skulls of Europe, &c.' *Annals of Eugenics*, vol. iv, p. 109.

Morton, Dudley J. (1922–4). 'Evolution of the Human Foot.' *Amer. J. Phys. Anthro.*, vol. v, p. 305, 1922; vol. vii, p. 1, 1924.

Pearson, Karl (1898). 'On the Reconstruction of the Stature of Prehistoric Races.' *Roy. Soc., Phil. Trans.*, Series A, vol. cxcii, p. 169.

Pearson, Karl, and Bell, Julia (1919). 'A Study of the Long Bones of the English Skeleton, Pt. 1. The Femur.' *Drapers' Company Research Memoirs*, Cambridge University Press.

Remane, Adolf (1921). 'Beiträge zur Morphologie des Anthropoidengebisses.' *Archiv f. Naturgesch.* Jhg. 87, Abt. A, Heft 11, p. 1.

Reynolds, E., and Hooton, E. A. (1936). 'Relation of the Pelvis to Erect Posture. An Exploratory Study.' *Amer. J. Phys. Anthro.*, vol. xxi, p. 253.

Schoetensack, O. (1908). *Der Unterkiefer des Homo Heidelbergensis, &c.* (Leipzig.)

Schwalbe, Gustav (1901). 'Über die spezifischen Merkmale des Neanderthalschädels.' *Verh. Anat. Ges. Erg.-H. Anat. Anz.*, vol. xv, p. 44.

—— (1914). 'Kritische Besprechung von Boule's Werk, L'homme fossile de la Chapelle-aux-Saints, mit eigenen unterschungen.' *Zeit. f. Morph. u. Anthrop.*, vol. xvi, p. 527.

Sera, G. L. (1909). 'Nuove osservazioni ed induzioni sul cranio di Gibraltar.' *Arch. per l'Antrop. e la Etnol.*, vol. xxxix, p. 152.

Shaw, J. C. M. (1931). *The Teeth, the Bony Palate, and the Mandible in Bantu Races of South Africa* (London).

Shellshear, J. (1937). 'The Brain of the Aboriginal Australian. A Study in Cerebral Morphology.' *Roy. Soc., Phil. Trans.*, Series B, vol. ccxxvii, p. 293.

Shellshear, J., and Smith, Sir G. Elliot (1934). 'A Comparative Study of the Endocranial Cast of *Sinanthropus*.' *Roy. Soc., Phil. Trans.*, Series B, vol. ccxxiii, p. 469.

Smith, Sir G. Elliot (1927). *The Evolution of Man* (London).

Straus, W. L., Jr. (1927). 'Growth of Human Foot and its Evolutionary Significance.' Carnegie Institution of Washington, *Contribution to Embryology*, vol. xix, p. 93.

Symington, J. (1915). 'On the Relationship of the Inner Surface of the Cranium to the Cranial Aspect of the Brain.' *Edin. Med. J.*, Feb., p. 3; also *J. Anat.*, vol. l, p. 111, 1916.

Thomson, Arthur (1916). 'On the Presence of Genial Tubercles on the Mandible of Man and their Suggested Association with the Faculty of Speech.' *J. Anat.*, vol. l, p. 43.

Todd, T. Wingate (1920–1). 'Age Changes in the Pubic Bone.' *Amer. J. Phys. Anthro.*, vols. iii and iv.

Vallois, H. (1937). 'La Durée de la Vie chez l'Homme Fossile.' *L'Anth.*, vol. xlvii, p. 499.

VERNEAU, RENÉ (1906). *Les Grottes de Grimaldi. Anthropologie*, vol. ii, fasc. 1, Monaco.

VIRCHOW, H. (1920). *Die menschlichen Skelettreste aus dem Kämpfe-schen Bruch im Travertin von Ehringsdorf bei Weimar.* (Jena.)

WALLIS, RUTH S. (1931). *How Children Grow; an Anthropometric study of Private School Children from Two to Eight Years of Age.* University of Iowa Studies in Child Welfare, New Series, no. 208.

WEIDENREICH, FRANZ (1928). *Der Schädel-Fund von Weimar-Ehringsdorf.* (Jena.)

—— (1936). 'The Mandibles of *Sinanthropus Pekinensis*: A Comparative Study.' *Palaeon. Sin.*, Series D., vol. vii, fasc. 3.

—— (1936). 'Observations on the Form and Proportions of the Endocranial Casts of *Sinanthropus Pekinensis, etc.*' *Palaeon. Sin.*, Series D, vol. vii, fasc. 4.

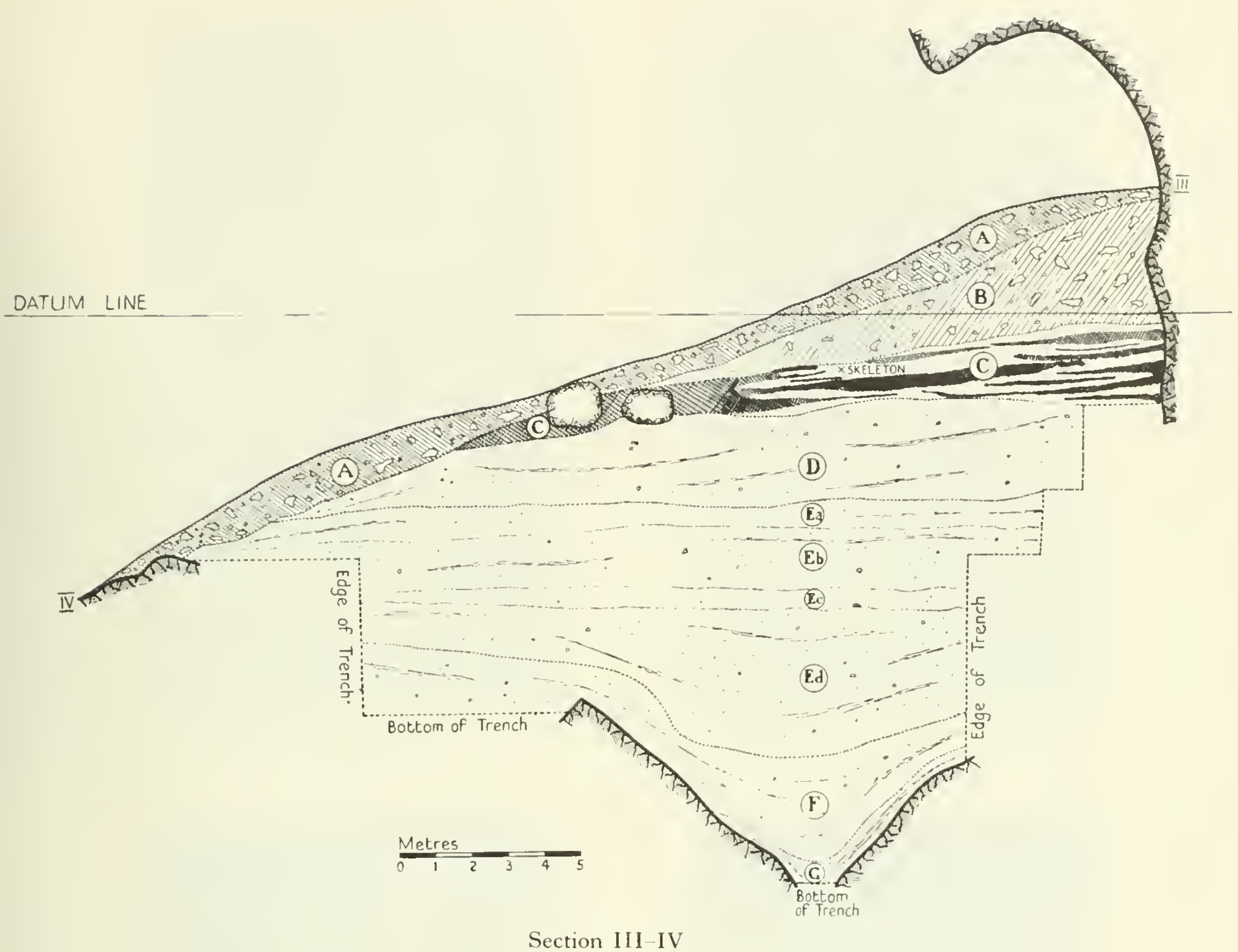
WEINERT, HANS (1925). *Der Schädel des eiszeitlichen Menschen von Le Moustier, etc.* (Berlin.)

—— (1936). 'Der Urmenschenschädel von Steinheim.' *Zeit. f. Morph. u. Anthrop.*, vol. xxxv, p. 463.

—— (1937). *Entstehung der Menschenrassen.* (Stuttgart.)



INDEX



Section III–IV

Key to Archaeological Layers

A Bronze Age to Recent
B Upper Levalloiso-Mousterian
C Lower Levalloiso-Mousterian
D Lower Levalloiso-Mousterian

E*a*, E*b*, E*c*, E*d* Upper Acheulean (Micoquian)
F Upper Acheulean
G Tayacian

SECTION OF STRATA, ET-TABŪN

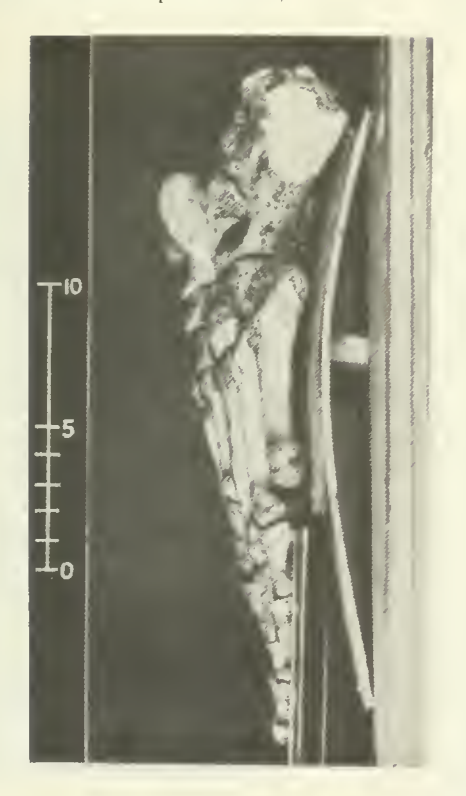




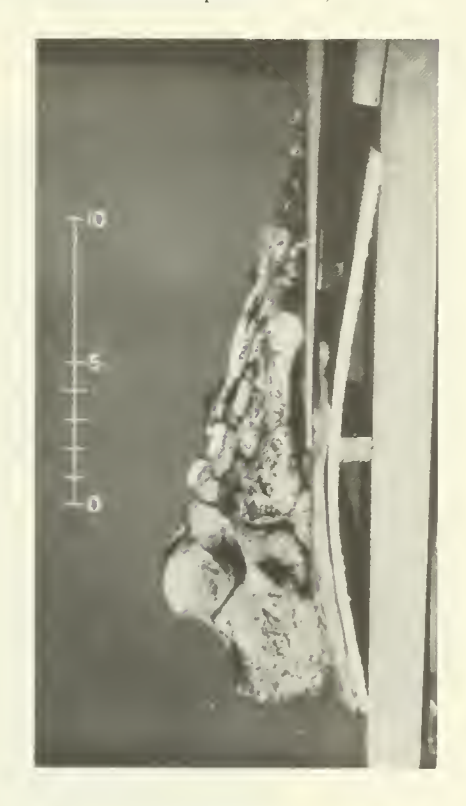
A. Dorsal aspect of foot, Skhūl IV



B. Dorsal aspect of foot, Tabūn I



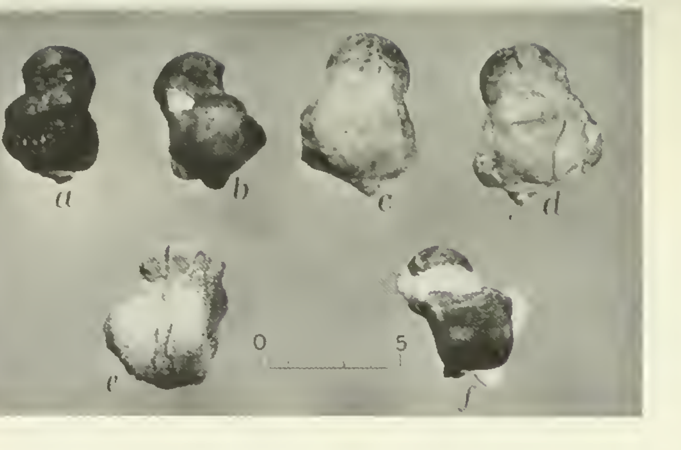
C. Lateral aspect of foot, Skhūl IV



D. Lateral aspect of foot, Tabūn I

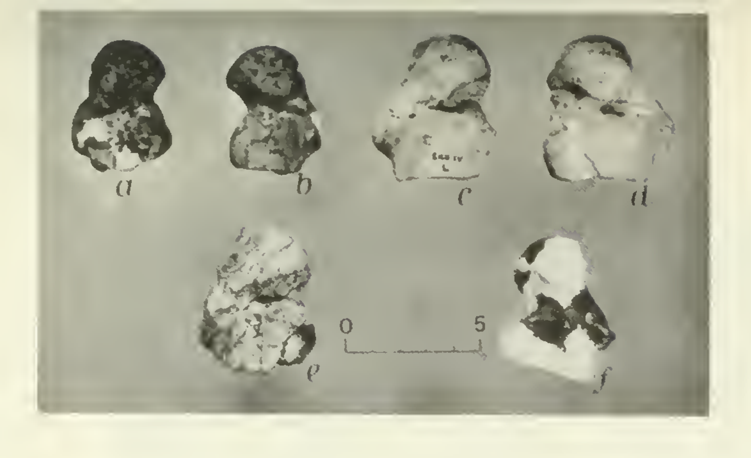
THE FOOT





A. Talus, dorsal aspect

a, Tabūn I, left *b*, Tabūn I, right
c, Skhūl IV, left *d*, Skhūl IV, right
e, Skhūl V, left *f*, Skhūl VII, right

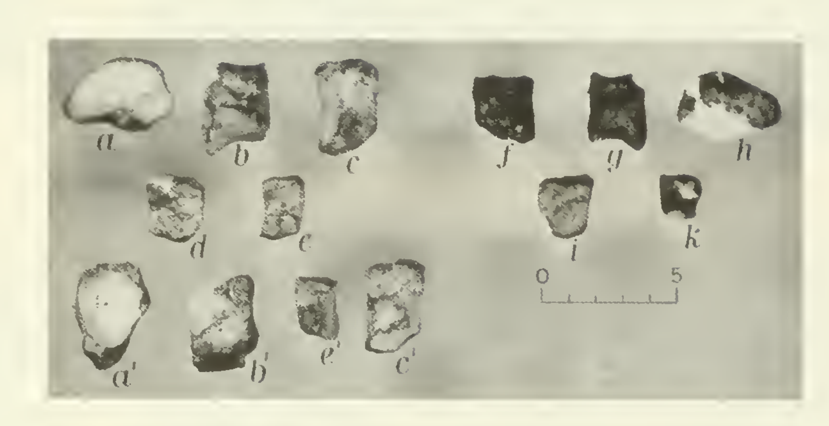


B. Talus, plantar aspect

The same bones arranged as in A.

C. Calcaneus, dorsal aspect

a, Tabūn I, left *b*, Tabūn I, right
c, Skhūl IV, right *d*, Skhūl IV, left



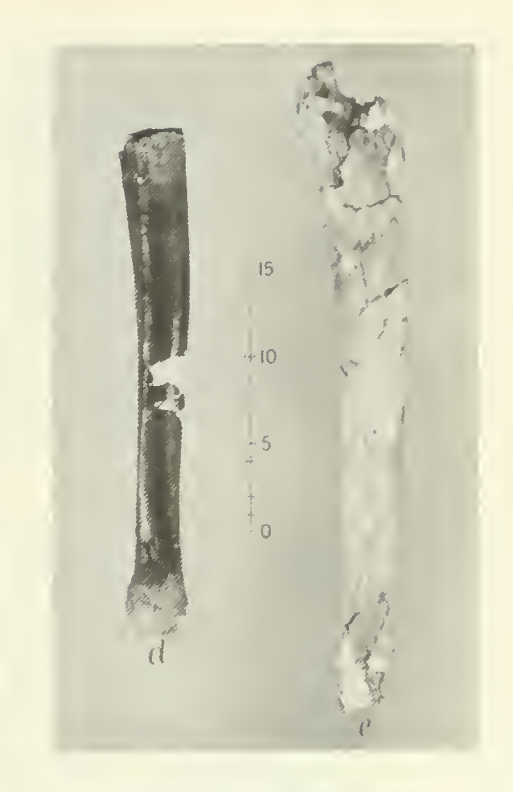
D. Views of distal Tarsal bones

a, Skhūl IV, left navicular, distal face
a', ,, right navicular, proximal face
b, ,, left cuboid, plantar face
b', ,, right cuboid, medial face
c, ,, left cuneiform I, medial face (inverted)
c', ,, right cuneiform I, lateral face (inverted)
d, ,, left cuneiform III, lateral face
e, Skhūl IV, left cuneiform II, lateral face
e', ,, right cuneiform II, medial face
f, Tabūn I, right cuneiform I, medial face (inverted)
g, ,, right cuboid, plantar face
h, ,, right navicular, distal face
i, ,, right cuneiform III, medial face
k, ,, right cuneiform II, lateral face

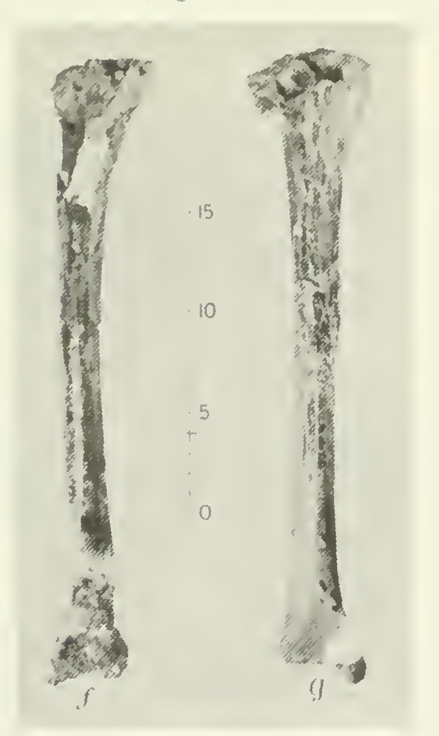


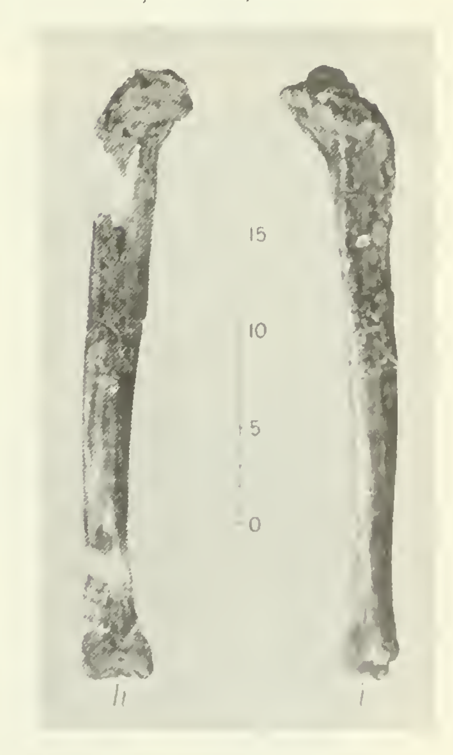


A. *a*, Skhūl IV, left; *b*, Sikh, right; *c*, Skhūl IV, right



B. *d*, Medial view of Skhūl VI, left; *e*, Skhūl V, left





C. *f*, Anterior view, Tabūn I, left; *g*, Tabūn I, right

D. *h*, Lateral view, Tabūn I, left; *i*, Tabūn I, right

TIBIA





A. Anterior view of Tibia and Fibula in articulation: *a*, Skhūl IV, left; *b*, Skhūl IV, right; *c*, Sikh, right

B. Medial aspect of Fibula: *d*, Skhūl IV, left; *e*, Skhūl IV, right; *f*, Sikh, right

C. Lateral aspect of Fibula: *g*, Skhūl IV, left; *h*, Skhūl IV, right; *i*, Sikh, right





A. Anterior aspect of the femora of Skhūl IV. *a*, left; *b*, right



B. *c*, *d*, Posterior aspect of the same



C. *e*, Anterior view of the right femur of Tabūn I. The os coxae is cemented to the head of the bone. *f*, Anterior view of the left femur of Spy I (from a cast)



D. *g*, Posterior view of the right femur of Tabūn I; *h*, Similar view of the femur of Spy I (from a cast)

FEMUR

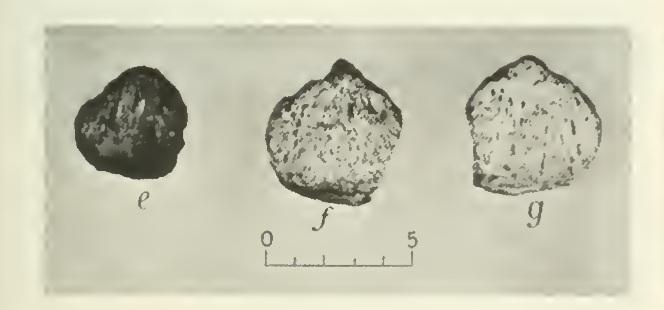




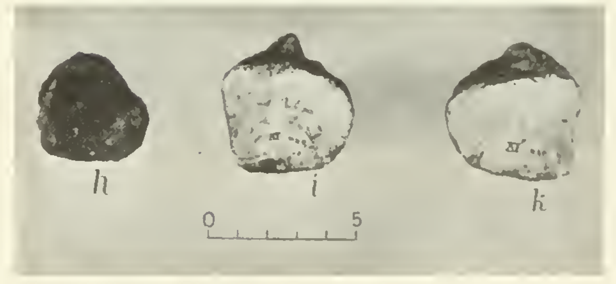
A. *a*, Anterior view of right femur of Skhūl V, the os coxae being cemented to the head of the bone; *b*, Shaft and distal end of left femur of Skhūl V



B. *c*, *d*, Lateral view of the right (middle two-fourths of shaft) and left femora of Skhūl VI



C. *e*, Anterior view of the right patella of Tabūn I. The pointed or distal margin is above; *f*, *g*, Similar view of the right and left patellae of Skhūl IV



D. *h*, The posterior or articular surface of the right patella of Tabūn I, apex above—base below; *i*, *k*, Similar view of the right and left patellae of Skhūl IV

FEMUR AND PATELLA





A. Skhūl IV, right, lateral aspect



B. Skhūl IV, left, lateral aspect



C. Skhūl IX, left, to show entrance of wound in the head of femur. The femur is much flexed and rotated inwards



D. Skhūl IV, ventral, anterior view of pelvis



E. Skhūl IX, view of the strongly flexed left femur, which is cemented within the acetabulum

OS COXAE





A. Cervical region of spinal column of Skhūl V, viewed on its right lateral aspect



B. The same as A, viewed on its dorsal aspect



C. Dorsal region of Skhūl V viewed on its posterior aspect with left ribs attached (5–12). The vertebral series begins with the spinous process of D. 3 and ends with D. 12



D. The same as C, viewed on its ventral aspect





A. *a*, upper or cranial surface of right clavicle of Skhūl V; *b*, left clavicle of the same; *c*, proximal end of left clavicle, anterior surface, Skhūl IV; *d*, lower surface of left clavicle, Skhūl I



B. *a*, right, *b*, left clavicle of Skhūl V, viewed on its lower or caudal aspect; *c*, proximal end, deep or dorsal aspect, left clavicle of Skhūl IV; *d*, upper surface of left clavicle of Skhūl I

C. *e*, first rib of left side, Skhūl IV, shown on its upper or cranial surface. The dorsal part is missing. *f*, eighth, *g*, seventh rib of the left side of Tabūn I; *h*, eighth rib (left) of Skhūl IV

CLAVICLE AND RIBS





A. Left hand, Skhūl V, dorsal aspect



B. Left hand, Tabūn I, dorsal aspect



C



D

C. Dorsal aspect of the separated metacarpals of the left hand of Tabūn I; *a–e*, Metacarpals I–V

D. Isolated carpal bones: *a*, left pisiform of a Sikh viewed on its articular (dorsal) aspect, the distal end being to the left; *b*, same aspect of the left pisiform of Tabūn I; *c*, left cuneiform, ulnar aspect, of Skhūl IV, showing large process at distal end; *d*, similar aspect of left cuneiform of Sikh; *e*, left uncinate, lateral aspect, of Sikh; *f*, the same aspect of left uncinate, Tabūn I





A. *a*, left radius and ulna of a Sikh articulated and seen on their volar aspect; *b*, *c*, similar aspect of the bones of the right and left forearm of Skhūl IV; *d*, the same of the right bones of Skhūl V



B. *a*, volar aspect of the articulated left radius and ulna of Tabūn I. *b*, the same aspect of a cast of the right radius of the Neanderthal skeleton with the proximal part of the right ulna; *c*, volar aspect of left radius and ulna of Skhūl VII—a woman



C. *a*, radial aspect of left ulna of Tabūn I; *b*, volar aspect of left radius of Tabūn I

RADIUS AND ULNA





A. *a*, flexor aspect of right humerus (distal two-thirds) of Skhūl IV; *b*, flexor aspect of left humerus of Skhūl IV; *c*, flexor aspect of left humerus of Tabūn I



B. *a*, *b*, *c*, lateral aspect of the same



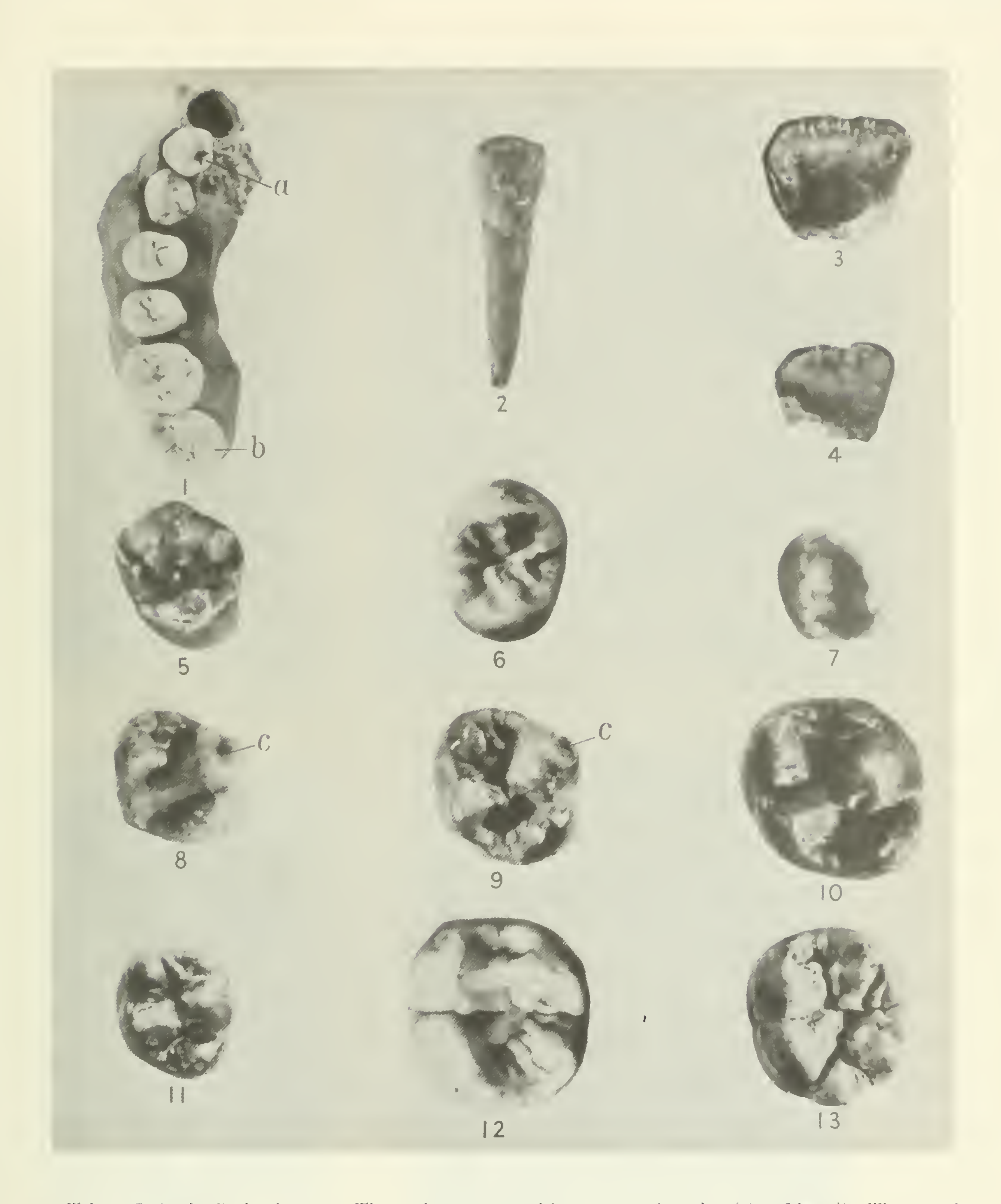
C. *a*, *b*, *c*, extensor (posterior) aspect of the three humeri shown in B; *d*, proximal three-fourths of right humerus of Tabūn I



D. *a*, dorsal (extensor) aspect of the right Neanderthal radius (from a cast); *b*, same aspect of left radius of Tabūn I; *c*, dorsal aspect of left radius (distal end missing) of Skhūl VII; *d*, the same aspect of the corresponding right bone

HUMERUS: RADIUS





1. Tabūn, Series I. Occlusal aspect. The teeth are arranged in sequence from I–2 (*a*) to M–2 (*b*). They are the upper right permanent teeth. The fragment of the maxilla, with empty socket for I–1, is included in the photograph. 2. Lingual aspect, upper right lateral incisor, Tabūn, Series I. 3. Lingual aspect of the crown of the upper right i–1 of Skhūl I. 4. Lingual aspect of the upper right i–2 of Skhūl I. 5. Lingual aspect of the crown of the upper left permanent canine of Skhūl I. 6. Occlusal aspect of the upper right Pm–2, Tabūn, Series I. 7. Occlusal aspect of the upper right m–1 of Skhūl I. 8. Upper right m–2, Skhūl I. *c*, Carabelli pit. 9. Occlusal aspect, upper right M–1, Skhūl I. *c*. Carabelli pit on the first lingual cusp. 10. Same aspect of M–2, right, Skhūl X. 11. Same apect of M–1, right, Tabūn, Series II. 12. Occlusal aspect of the lower left M–1 of Tabūn, Series III. 13. Corresponding molar from Skhūl X.

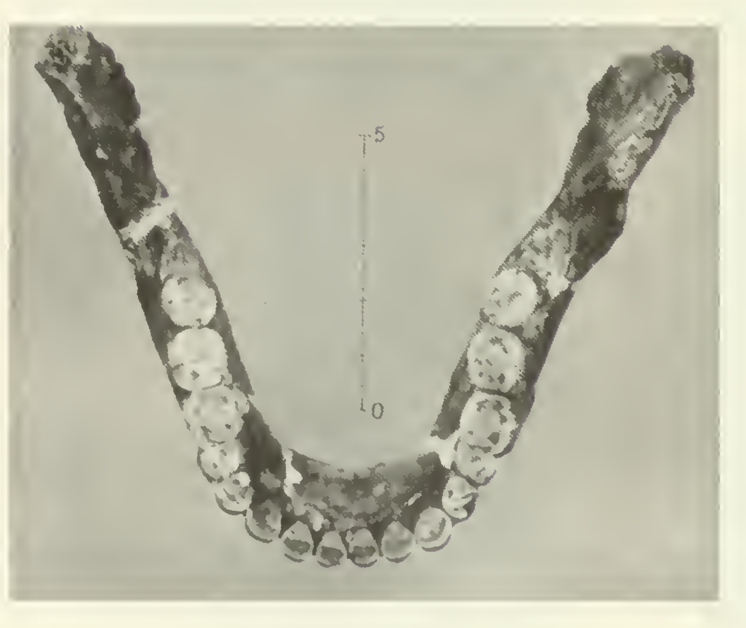
DENTITION



A. Left lateral aspect of Tabūn I, photographed at right angles to mid-sagittal plane



B. Anterior aspect, Tabūn I



C. Occlusal aspect, Tabūn I



D. Occlusal aspect, Tabūn II

MANDIBLE

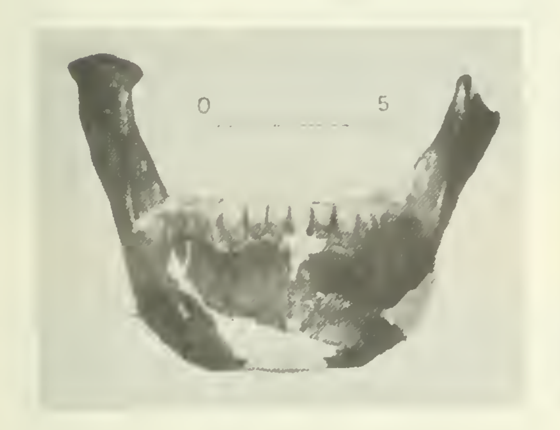




A. Left lateral aspect, Tabūn II, photographed at right angles to mid-sagittal plane



B. Same as A, Skhūl V



C. Anterior aspect, Tabūn II



D. Anterior aspect, Skhūl V



E. Occlusal aspect of Skhūl V

F. Radiograph of left half of mandible, Skhūl I

MANDIBLE



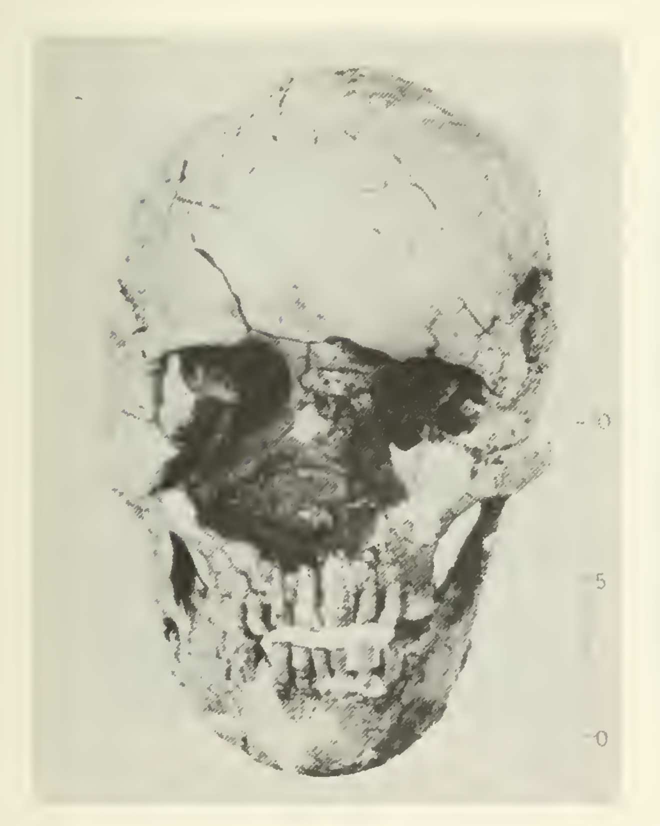
PLATE XVII



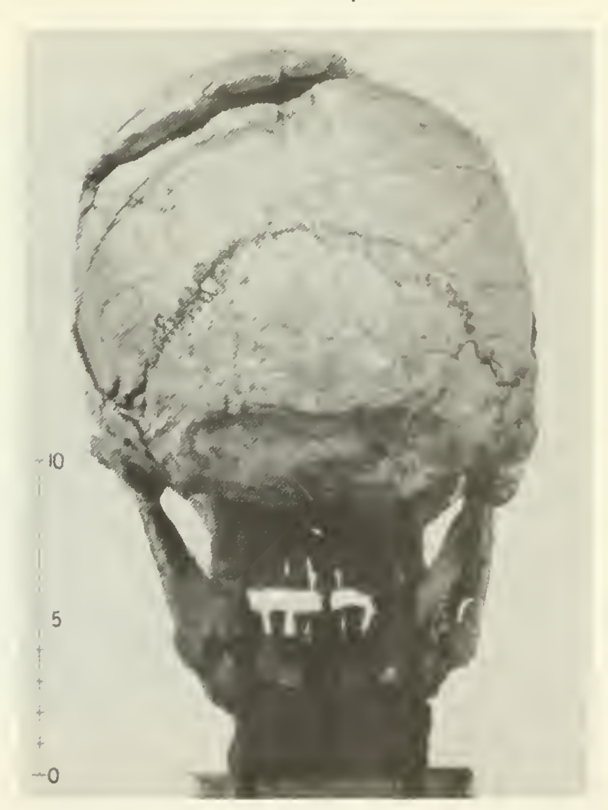
A. Right cranial profile



B. Left cranial profile



C. Frontal view of skull



D. Occipital view of skull

In all views specimens were orientated on the Frankfort plane

SKHŪL V





A. Basal view of cranium of Skhūl V



B. Vertex aspect of cranium of Skhūl V, with fragment of vault removed, exposing the base in its internal aspect. In A and B photographs were taken vertically to the Frankfort plane



C. The temporo-mandibular region on the left side of the cranial base of Skhūl IV



D. A similar view of the corresponding parts on the cranial base of Tabūn I

SKHŪL V, SKHŪL IV, TABŪN I

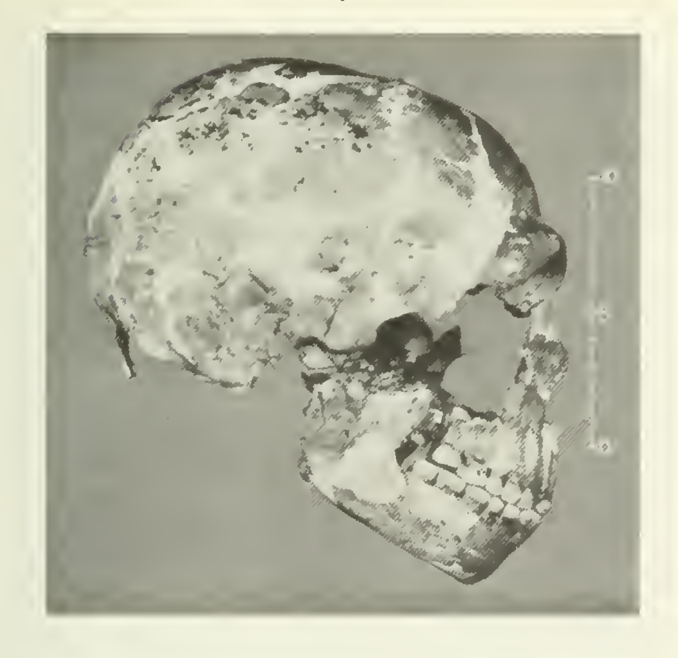




A. Left lateral aspect of skull



B. Frontal aspect of skull



C. Right lateral aspect of skull



D. Occipital aspect of skull

Photographs were taken with the skull orientated on the Frankfort plane

TABŪN I





A. Left lateral view—after restoration. For pre-restoration state see Plate XXI—D



B. Frontal view



C. Right lateral view



D. Occipital view

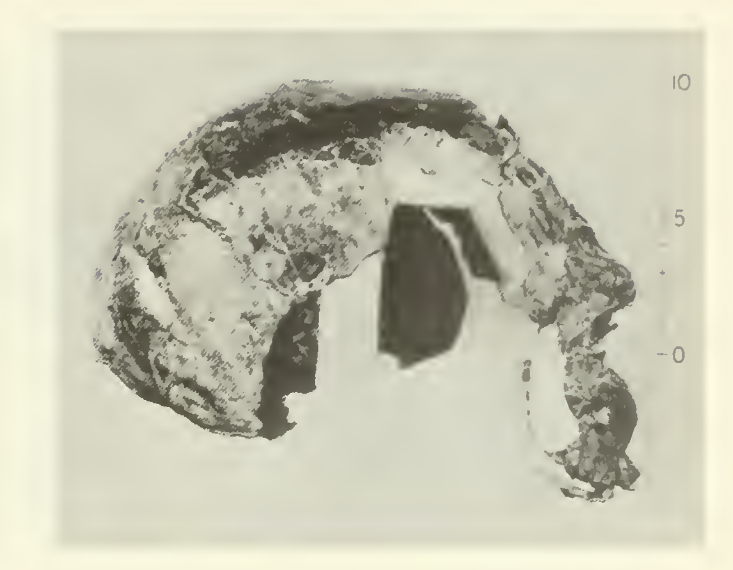
All views were taken with the skull orientated on the Frankfort plane

SKHŪL IV

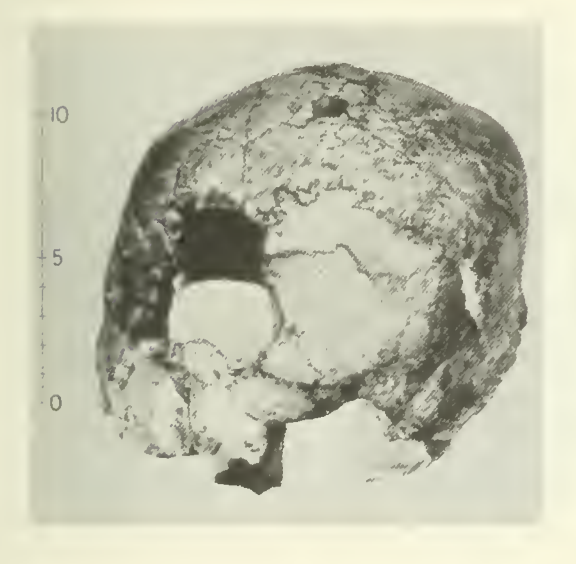




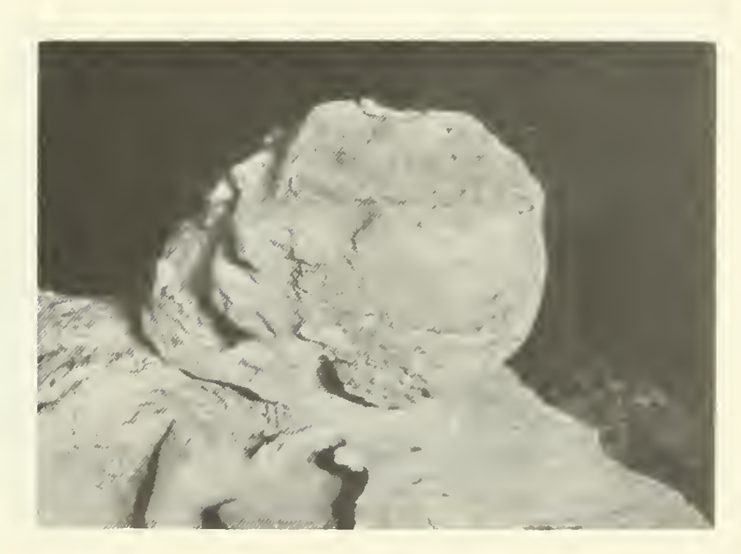
A. Frontal view



B. Right lateral view



C. Occipital view



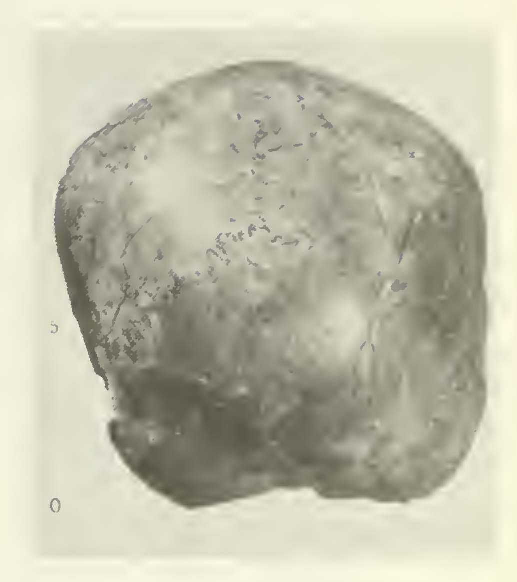
D. Left lateral view of Skhūl IV, after it had been cleared from breccia but before restoration

A, B, and C are views of Skhūl IX





A. Skhūl I, right profile of cranium



B. Skhūl I, occipital view of cranium



C. Skhūl I, left profile of cranium



D. Mandible, viewed on its occlusal aspect

In A, B, and C the cranium was placed on the Frankfort plane





Skhūl I

A. Left femur of an English child, anterior aspect. B. Similar aspect of Skhūl I. C. Left tibia, anterior view. D. Left tibia, English child. E. Right tibia, anterior view







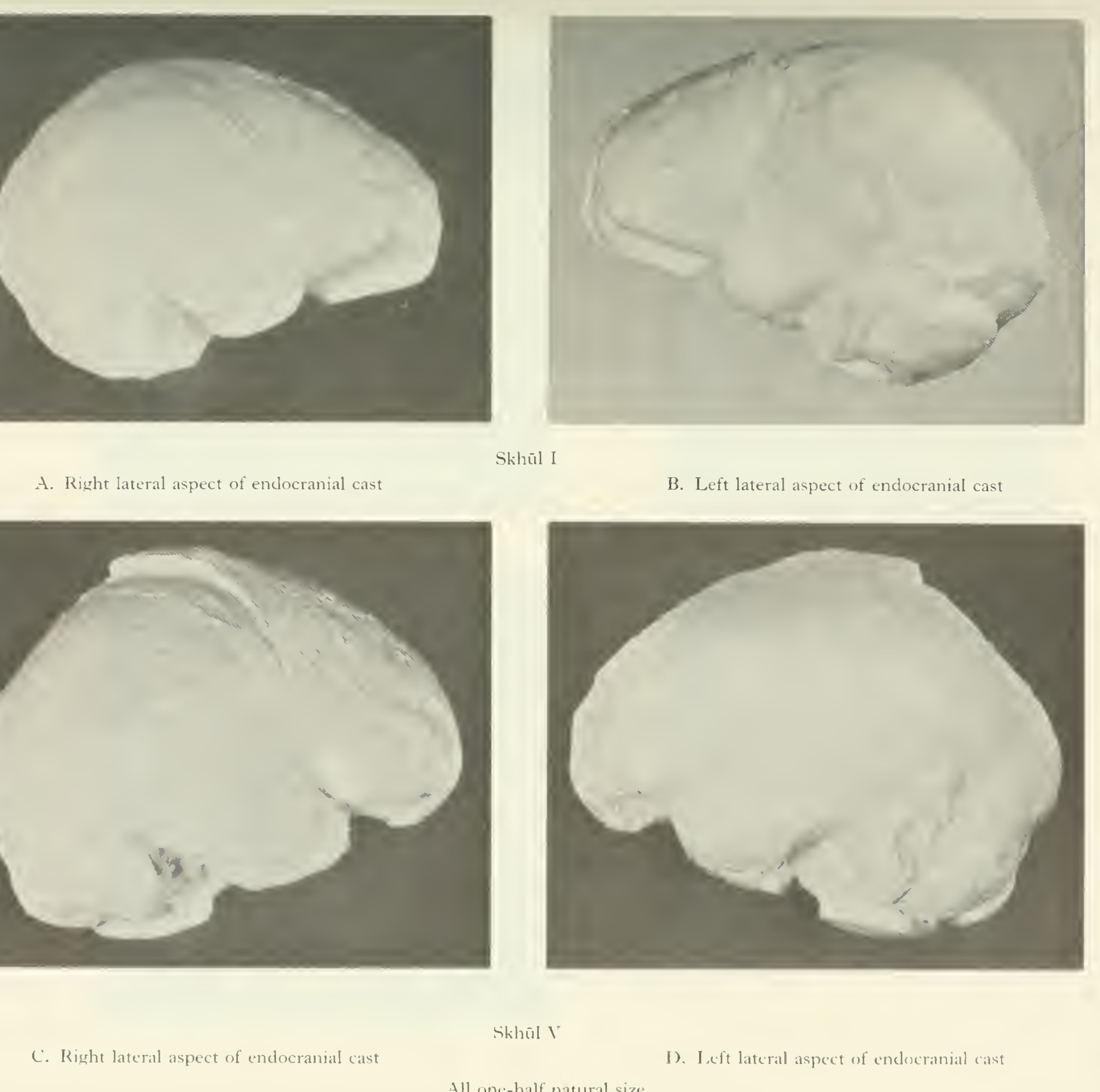
Skhūl VIII

F. Middle part of shaft of right femur, anterior view. G. Right tibia, anterior view. H. Left tibia, anterior view

Skhūl I

K. Mandible, left lateral aspect, at right angles to mid-sagittal plane. L. Mandible, anterior aspect





Skhūl I

A. Right lateral aspect of endocranial cast

B. Left lateral aspect of endocranial cast

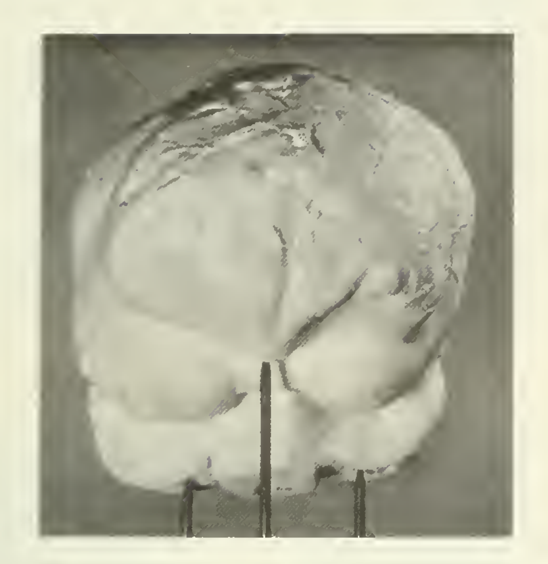
Skhūl V

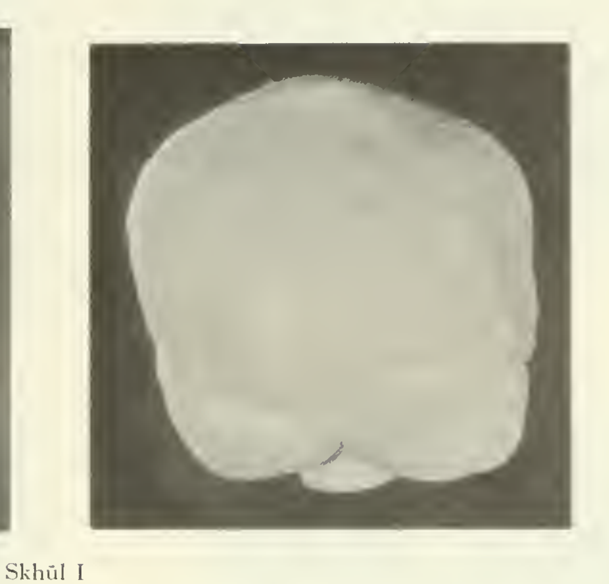
C. Right lateral aspect of endocranial cast

D. Left lateral aspect of endocranial cast

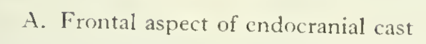
All one-half natural size







Skhūl I



A. Frontal aspect of endocranial cast

B. Occipital aspect of endocranial cast





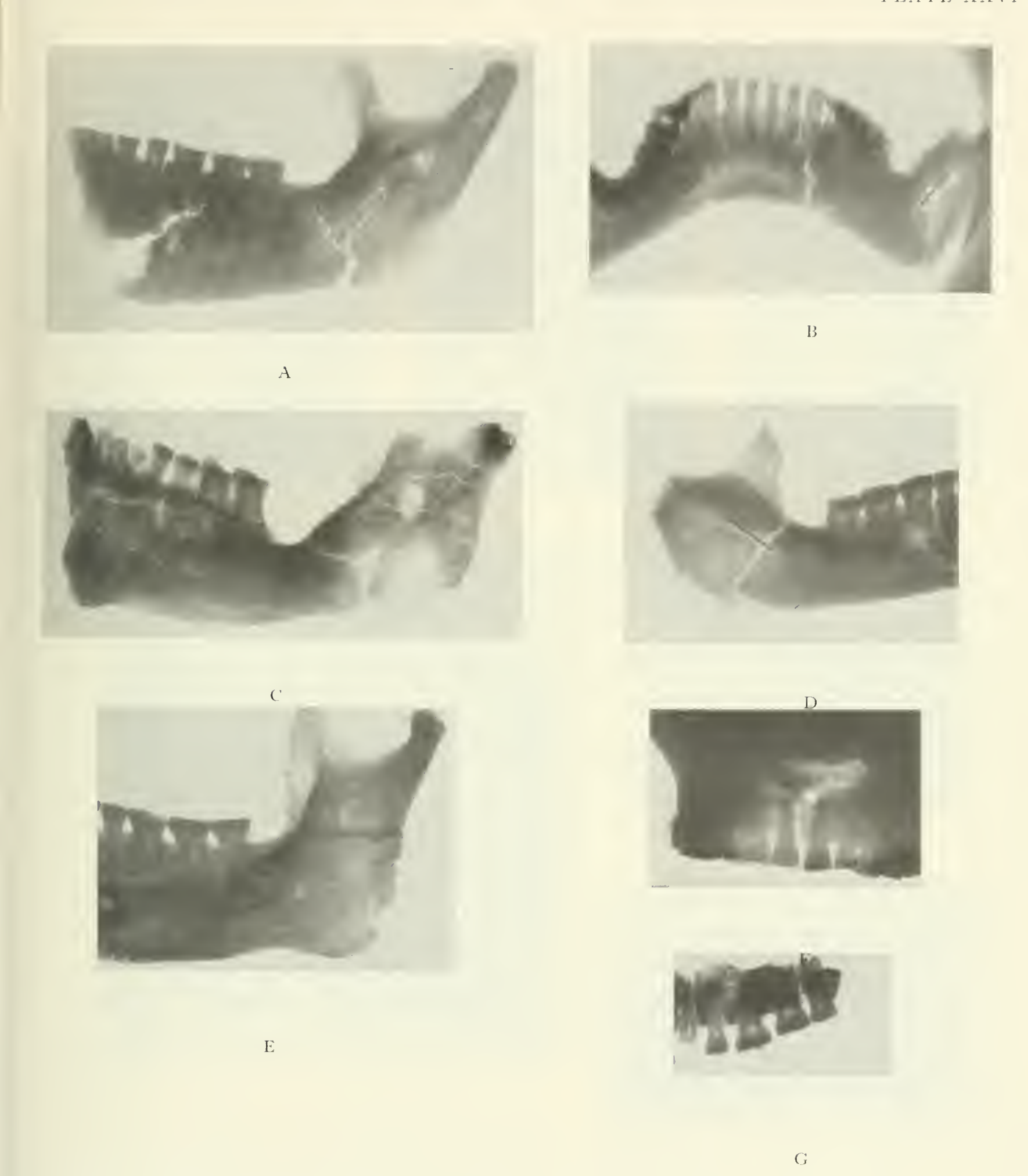
Skhūl V

C. Frontal aspect of endocranial cast

D. Occipital aspect of endocranial cast

All one-half natural size





A. Tabūn II, right half of mandible, seen in profile. B. Tabūn I, symphyseal part of mandible, from an antero-posterior exposure. C. Skhūl IV. Left half of mandible exposed in profile. D. Tabūn I, right ascending ramus and molar part of the mandible as far forwards as Pm-2 exposed laterally. E. Skhūl V, left ascending ramus with the same extent of the body of the mandible as in D. F. Skhūl V, upper incisors and the alveolar region of the maxilla, exposed from the front. G. Tabūn I. The upper premolar and molar teeth of the left side.

RADIOGRAPHS OF MANDIBLES AND OF TEETH





A. Radiograph of proximal end of femur (left) Skhūl IV. B. Radiograph of proximal end of femur (right) Tabūn I. C. Radiograph of modern femur. D. Radiograph of the occipital aspect of the skull of Skhūl I. The lambdoid suture can be traced; above the site of the inion is the appearance given of the structure described on p. 314. E. Radiograph of left ramus and part of the body of the mandible of Skhūl VI, with third molar showing large pulp cavity. F. Radiograph of ramus and part of the body of a mandible from the Mesolithic stratum of Mount Carmel.

RADIOGRAPHS



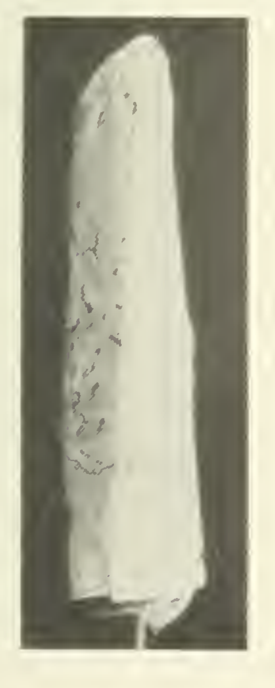




A B

A. The wound of the left hip-joint of Skhūl IX exposed in its entire length by removal of the ischial fragments (*x* in B). *x*, entrance of wound on the lateral aspect of the head of the femur—the lateral fragment being missing. *y*, its entrance on the wall of the pelvis

B. Radiograph of the hip-joint of Skhūl IX, exposed on its pelvic aspect, the neck of the femur being above. *x*, placed on the ischial wall, below the rectangular perforation







C D E

C. Photograph of a cast taken from the interior of the perforation or wound. *x*, marks the entrance on the femoral head; the scale along the narrower and contracting side of the cast is marked in cms. D. The axillary part of the left scapula of Tabūn I, viewed on its dorsal aspect; *bf*. Boule's fossa. E. Dorsal view of the left (scaphoid) scapula of Skhūl IV









